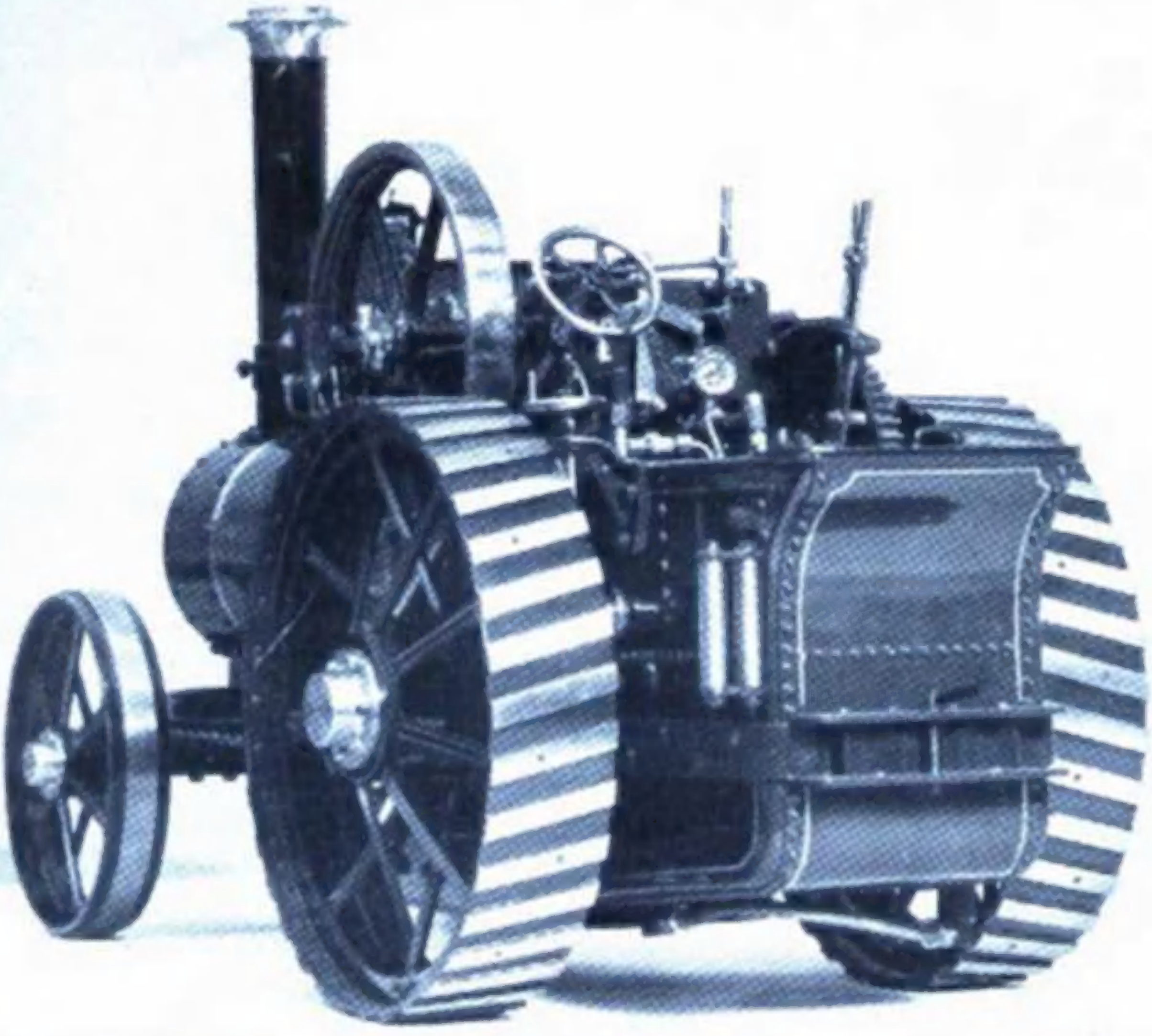
THE MODEL ENGINEER



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THE
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Our Cover Picture

Every so often, the question of photographing models comes up for discussion, and just as often, the opinion is expressed that the most realistic effects are obtained when the camera has been placed at somewhere near the point of view from which the full-size prototype would normally be seen. Just such a photograph is the basis of our cover picture this week; it was taken by Fox Photos Ltd., and has caught just the right "atmosphere," if from a somewhat unconventional viewpoint.

Incidentally, the model is of interest in that it illustrates another matter to which we have made recent reference; it is not a scale model of a particular prototype, but is an excellent example of the "M.E." traction engine, and is, therefore, a free-lance job. The design is strictly in accordance with fundamental prototype practice, reduced to 1-in. scale; therefore, the result is a neat, attractive and pleasing little engine which, in spite of its simplicity, disarms criticism. The proportions of the control handles are worth noting. None is grossly over-scale, yet they will all outlast the working life of the engine.

SMOKE RINGS

Outdoor Tracks

WITH THE approach of the Easter break, owners of outdoor locomotive tracks are beginning to look forward to resuming the running of locomotives. At the present moment, most of the tracks are being carefully examined to see how they have withstood the rigours of the winter weather, and there may be some that have suffered to an extent that surprises their owners. In such cases, some quite extensive repairs will be found to be necessary before really trouble-free running can be expected, and the question arises as to whether much of the damage could have been prevented. It is always a dubious policy to leave a track entirely to winter weather, without periodic inspection and without taking any kind of protective measures at the close of the summer season. The worst enemy of tracks is the wide variation of temperature, combined with the effects of damp atmosphere, and there are certain precautions which, if taken, will do much to mitigate the effects. With iron or steel rails, the greatest bugbear is rust; but if, before the advent of winter, the rails are well greased, or coated with a thickish oil, little rust will form. This precaution may seem to be an expensive one, but it probably pays for itself well and truly by the longer life it gives to the track.

Damage from frost is not so easy to prevent; its worst form is the distortion of rails under the influence of expansion and contraction. Some thought given to the initial design of the joints between each length of rail can do much to stop distortion, and some consideration given to this matter is always well worth while.

We hope, however, that we shall not hear of any really serious damage to a track; the past winter has been a very trying one, but probably not so severe anywhere as to put a locomotive track entirely out of action.

The Andover Rally

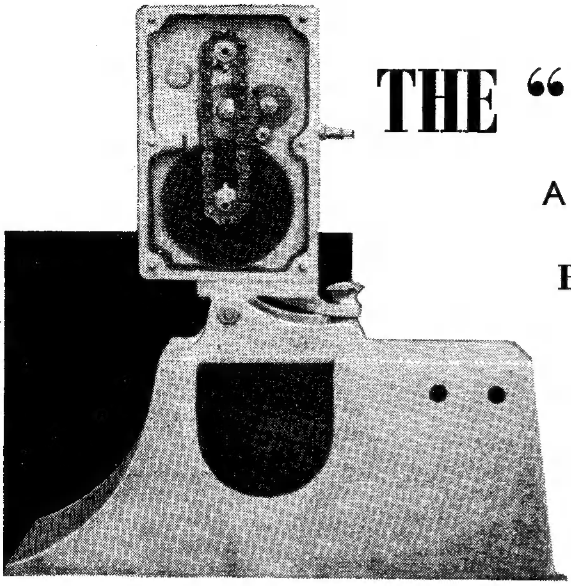
WE HAVE received some further news of the Road Locomotive Rally to be held at Andover on Easter Monday, April 6th. Mr. Pemble tells us that there will be eight engines in steam, and there may also be a steam car on view. There will be only two actual events: a grand parade and an obstacle race; for the rest of the time the intention is to give ample opportunity for visitors to enjoy themselves, either by watching the fine old engines at work, or by having a ride and possibly a drive.

This epoch-making event will be held at Dance's Field, Batchelors Barn, Vigo Road, Andover. Visitors going by car should look out for white directive boards, arrow-shaped and carrying the legend "Road Loco Rally" in black lettering. Those going by rail should book to Andover Junction station, whence the field is about 20 minutes' walk.

Everything possible is being done for the comfort and convenience of visitors; car-park, refreshments and bar will all be available.

A Belgian's Sympathy

A RESPECTED Belgian subscriber to the "M.E.," when renewing his subscription recently, enclosed a cheque for 1,000 Belgian francs as a contribution, as he put it, "for the poor people of Canvey Island for rescue." Naturally, we were impressed by this act of generosity, and we promptly forwarded the money to the Lord Mayor's "Flood Relief" fund, in the name of "a Belgian model engineer," since our good friend desired that the gift should be made anonymously. At the same time, we sent a suitable acknowledgment to the generous donor, because his desire for anonymity may mean that he will not be able to receive a direct reply from the Lord Mayor. His thoughtfulness, sympathy and generosity are none the less deeply appreciated by us all on the staff of THE MODEL ENGINEER.



THE "M.E." PROJECTOR

AN 8 MM. VERSION

By A. J. Cannon (Natal)

Exposed view, showing gear assembly. The assembly and gear ratios are given in detail in Fig. 5

THE "M.E." Cine Projector is a very well-known piece of apparatus in its 16 mm. and 9.5 mm. forms, but I do not remember seeing any previous description of this machine in the 8 mm. size. The finished machine looks almost identical to many others which have appeared in the pages of the MODEL ENGINEER through the years, so it is my intention to confine the present article as far as possible to those points of difference which have occurred, rather than a description of the complete machine.

The relative merits of these three gauges of film have been exhaustively discussed in contemporary magazines, and as so often happens, it is really a question of personal taste and circumstances. The 8 mm. size most certainly scores heavily on the question of running costs, and for home and family filming, we cannot see that anything bigger is necessary. After many trials, we decided that a screen size of 30 in. × 22 in. was big enough to use in any ordinary size living room, and 8 mm. film will give excellent quality pictures on a screen this size, or even larger. For a given standard of quality, 16 mm. films would cover four times this area : i.e. 60 in. × 44 in., but this would be more suitable for a small hall rather than home use.

With the advent of a baby and a cine camera in the family, it was not long before we had some film, but no projector. The war was over by a couple of years, but optical goods were in short supply and expensive, so I turned back my copies of THE MODEL ENGINEER to 1937 and 1938, and dug out the whole series dealing with the projector. I must confess that, apart from the principle involved, my knowledge of cine projectors was about sub-zero. However, "Kinemette" had made such a good job of that series, starting January 7th, 1937, that anyone could soon get a reasonable grasp of the whole subject. About this time I had the opportunity of purchasing a nice Dallmeyer projector lens of 1 in. focal length, f.1.8, so without considering what might be involved, this was purchased and an order sent off to Messrs. Roox Products for a set of rough castings for the "M.E." Projector, and laminations for induction motor stator and rotor. These castings were excellent in every way. By this time I was really interested in the subject, and decided that this was to be a really good effort, aiming at a good finish and long life. In short, a "model engineer" job.

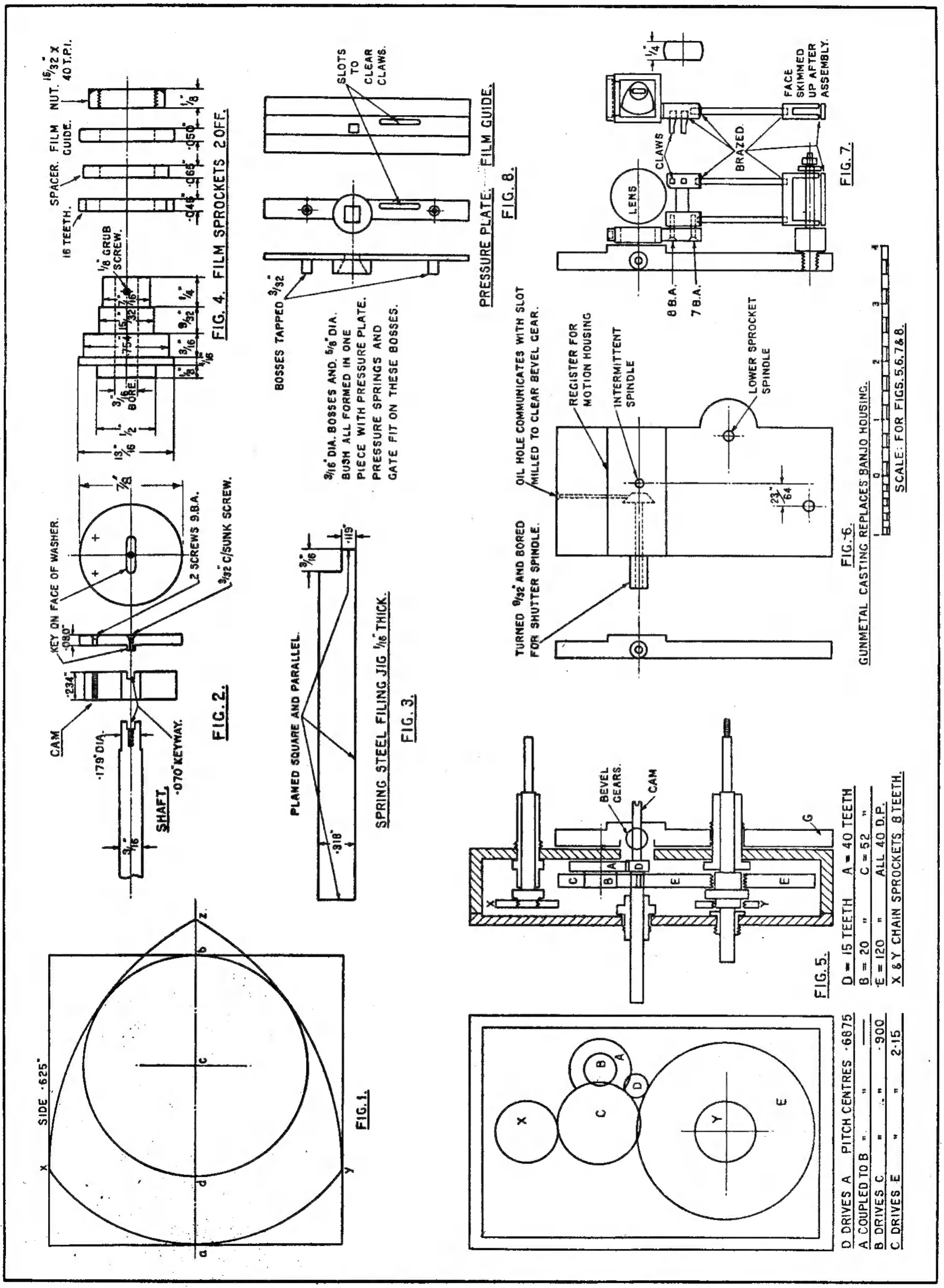
Working Drawings

A start was made by getting a scribbling book, and all notes and rough sketches were set down in this. I have been caught too often with scraps of paper which so often "get lost." Then several months of spare time work were put in at the drawing-board, and contriving, as far as possible, to make mistakes where they could be put right with a stroke of the pencil. Consideration was also given as to what standard threads should be used. It is always good practice to use only one standard on one machine. This ideal was given up because it so often happened that a stronger or better screw could be fitted by switching from B.A. to Whitworth, so eventually both these were used, in addition to some B.S.F. In an effort to avoid future difficulty over this, a written record was kept of every screw and nut used.

One would think that converting a 16-mm. machine to 8 mm. would largely consists of halving the dimensions, but this is far from true ! The first item of design considered was the cam. My method of "designing" this is set out in Fig. 1, and will probably give mathematically minded readers a fit; but remember it works ! First I must point out that the true pitch of the sprocket holes in 8 mm. film is 3.81 mm. and not, as often stated, 3.75 mm., also it should be noted that the accuracy of the picture spacing is determined by the accuracy of the sprocket-holes punched in the film by the manufacturers. The stroke of the cam, then is not very important within reasonable limits, provided it is a little *more* than 3.81 mm. or .150 inch. It is convenient to make the sketch (Fig. 1) eight times full size because the square bridle in which the cam works has a fixed internal size of $\frac{5}{8}$ in. each way. First, then, construct a square of 5 in. sides. Set off desired stroke of cam at *ad* (8 × 3.81 mm.). Bisect *db*. With radius *dc* construct base circle. Then *ca* equals radius of blank, and this radius cuts side of bridle at *x* and *y*. Then with radius equal to side of bridle from centre *x*, strike a radius from *y* to *z* and similarly from *y* strike a curve from *x* to *z*. When making the cam, it is necessary to file by hand from the point where this curve runs into the base circle, and this must be done with extreme care to ensure accuracy.

"Kinemette" is to be congratulated on the excellent method he devised for the making of this cam, and this method was followed, except for dimensions, which had to be altered as follows : *ad stroke* = .150 in. *db* = .625 in. − .150 in. = .475 in. = *dia. of boss. ac* = .150 in. + $\frac{.475\text{ in.}}{2}$ = .3875 in. = *radius of lobe of cam*

Then dia. of cam blank = .3875 in. × 2 = .775 in.


SIDE ·625"
FIG. 1.
CAM
·179" DIA.
SHAFT.
·070" KEYWAY.
·234"
KEY ON FACE OF WASHER.
·080"
2 SCREWS 9 B.A.
3/32" C/SUNK SCREW.
7/8"
FIG. 2.
PLANED SQUARE AND PARALLEL.
·318"
·119"
3/16"
SPRING STEEL FILING JIG 1/16" THICK.
FIG. 3.
13/16"
1/2"
3/16" BORE
·754
1/8" GRUB SCREW.
16 TEETH.
SPACER.
FILM GUIDE.
NUT. 16/32" x 40 T.P.I.
·045" ·065" ·050"
FIG. 4. FILM SPROCKETS 2 OFF.
BOSSES TAPPED 3/32"
3/16" DIA. BOSSES AND 5/16" DIA. BUSH ALL FORMED IN ONE PIECE WITH PRESSURE PLATE. PRESSURE SPRINGS AND GATE FIT ON THESE BOSSES.
SLOTS TO CLEAR CLAWS.
PRESSURE PLATE. FILM GUIDE.
FIG. 8.
BEVEL GEARS.
CAM
G
FIG. 5.
D = 15 TEETH A = 40 TEETH
B = 20 " C = 52 "
E = 120 " ALL 40 D.P.
X & Y CHAIN SPROCKETS 8 TEETH.
D DRIVES A PITCH CENTRES ·6875
A COUPLED TO B " " —
B DRIVES C " " ·900
C DRIVES E " " 2·15
TURNED 9/32" AND BORED FOR SHUTTER SPINDLE.
OIL HOLE COMMUNICATES WITH SLOT MILLED TO CLEAR BEVEL GEAR.
REGISTER FOR MOTION HOUSING
INTERMITTENT SPINDLE
LOWER SPROCKET SPINDLE
·23/64"
FIG. 6.
GUNMETAL CASTING REPLACES BANJO HOUSING.
SCALE: FOR FIGS. 5, 6, 7 & 8.
LENS
CLAWS
BRAZED.
8 B.A.
7 B.A.
FACE SKIMMED UP AFTER ASSEMBLY.
1/4"
FIG. 7.

The cam blank was turned from a piece of die steel to this diameter, and drilled and *bored* to a diameter of .179 in., being very careful *not* to radius the ends of this bore. Thereafter the method described by "Kinemette" in THE MODEL ENGINEER, May 19th, 1938 was followed, except that the jig was not removed from the lathe for drilling the 5/32-in. stud hole at a radius of .3875 in. This was drilled and tapped in the lathe, using a milling spindle and the "toolmakers button" method of measuring. When finally assembled and the stroke of the claws measured, it was found to be .151 in., and this was considered satisfactory, although .152 in. would have been better. An entirely new method of attaching this cam to the shaft was worked out, and this has proved very satisfactory (Fig. 2). The size of this intermittent spindle was limited to $\frac{3}{16}$ in., because it has to pass through the bevel gear which drives the shutter. It was turned down till the cam was a tight push fit, leaving a shoulder .004 in. all round; the length was made a few thousandths shorter than the cam. Then with the cam pushed on, the shaft was held in the three-jaw chuck and the centre hole opened up and tapped 3/32 in. Whitworth. Then a keyway was end-milled .070 in. wide and $\frac{1}{16}$ in. deep right across the shaft and partly into the cam on each side. A key and washer were made by holding a short piece of round mild steel $\frac{7}{8}$ in. diameter, vertically in the planer vice and forming a box-key on the end of it. This was then chucked and key turned to a length of $\frac{5}{8}$ in. and parted off .080 in. thick. When assembled on the cam with a 3/32 in. countersunk screw in the shaft, plus two 9 B.A. into the body of the cam, this made a very satisfactory keyed arrangement. With this arrangement the boss on the cam becomes merely a guide line.

The square bridle was cut from a solid piece of flat gunmetal by first planing the two sides flat and parallel and then drilling a $\frac{9}{16}$-in. hole in one end. The material was then held in a 4-jaw chuck with the lathe mandrel locked, and the hole opened up to .625 in. square. This was done by mounting a simple milling spindle on the vertical slide and using a $\frac{1}{8}$ in. diameter end-mill 9/32 in. long. The lathe micrometer collars were used for measuring, and by exercising a little patience, this turned out an excellent job. A lubricator was formed on top of this bridle by making it $\frac{1}{8}$ in. higher than the original and then milling a slot in the top, leaving it very light. The slot was filled with wool and a small piece of gauze soldered to the edges. A small hole was drilled in the motion housing to line up with this, and it does not matter in what position the cam is standing, a drop of oil will always fall through the motion housing and settle on the gauze. There are two tiny holes from this slot down to the corners of the square bridle. The stroke of this cam and bridle is only half that of a 16 mm. machine, so to get sufficient penetration of the claws they must be raised much higher up than on the original machine. This brings them up to a point where the lateral action of the cam has more effect, which meant that a new gate had to be made, with a longer base to put the gate carrying-pin below the claws.

Film Guide

It is essential that the film guide (Fig. 8) should be finished flat and smooth, and it required two efforts before this method was worked out. A piece of hard brass was planed a tight push fit in the dove-tail in the motion housing. It was then soldered on to a small solid block of brass, and this block held in the planer vice thus eliminating distortion by vice pressure. Then the film groove was planed out, and it was finished with a very sharp tool carefully oil-stoned to give the best possible machine finish. This groove should be made wide enough to take a piece of film *and* have a little shake. Film is not very accurate stuff compared with metal. Also the "picture area" was relieved about .003 in. deep. Next a slot $\frac{1}{16}$ in. wide was end-milled for the claws to come through and then a very narrow calico buff was used to polish the film groove. This process was stopped as soon as the brass took on the familiar "buffed" appearance, and the microscope showed a nice smooth surface. Once this finish is obtained, great care must be taken to preserve it. The last operation is to produce the tiny rectangular hole which masks the picture. It should be explained that this hole cannot be formed before the buffing process, because, the buff cuts away the side of the hole in a fraction of a second. The correct size of this aperture is .182 in. × .135 in. It must be remembered that the sides of this aperture will be projected and enlarged enormously, so anything rough or out of square will be very apparent. First a round hole was drilled, and then roughly filed to shape. Next, as in Fig. 3, a piece of spring steel $\frac{1}{16}$ in. thick and about three inches long was planed down to a neat fit in the film groove. The ends were then *planed* to shape in sketch to ensure they were quite true and square and then hardened. Next the spring steel jig was carefully assembled in the groove, with a piece of tissue paper to protect the surface, and when clamped in the vice, the hole was filed with a very smooth file until the file came on to the steel and ceased to cut; by this method the square aperture was finally produced so that on projection it looked quite reasonably rectangular, and the slight irregularity which showed up at the edges was covered by the black border round the screen. Referring to the pressure plate (Fig. 8), the $\frac{3}{16}$ in. bosses and bush are all formed in one piece with the plate.

Film Sprockets

For the sake of preserving the life of films it was decided to make the film path through the machine as easy as possible, and the first step in this direction was to retain large diameter film sprockets. These were accordingly made with 16 teeth, cut on planer with the dividing head, and a base diameter of .754 in. (Fig. 4). Great care was taken to ensure these sprockets should run dead true on their shafts. The $\frac{3}{16}$-in. hole was drilled, bored and reamed. The two rings of teeth were turned $\frac{13}{16}$ in. outside diameter, bored 15/32 in., and then mounted on a turned mandrel and the teeth cut down just below the base diameter on the planer. These 16-tooth sprockets introduced a new complication, in that a gear ratio of 16 to 1 was now necessary between the sprocket shaft and the intermittent spindle, which made one revolution for each picture pulled down.

This was accomplished by adding three extra gears (Fig. 5), one of 40 teeth coupled to one of 20 teeth to give a ratio of 2 to 1, and an idle gear of 52 teeth to correct the direction of rotation. The gear sizes and centres were all calculated to the usual formulae for D.P. gears, and the centres were set out by the "toolmakers button" method. These gears are mounted on little stub axles screwed tightly through the back of the gearbox and into the gunmetal casting (*G*). The 120-tooth spur gear and the two chain sprockets were all screwed on to the shafts, which were all turned and screwed from the solid to avoid pinning on collars. The diameter of all the wearing parts of the shafts was increased to $\frac{1}{4}$ in. for long life.

(To be concluded)

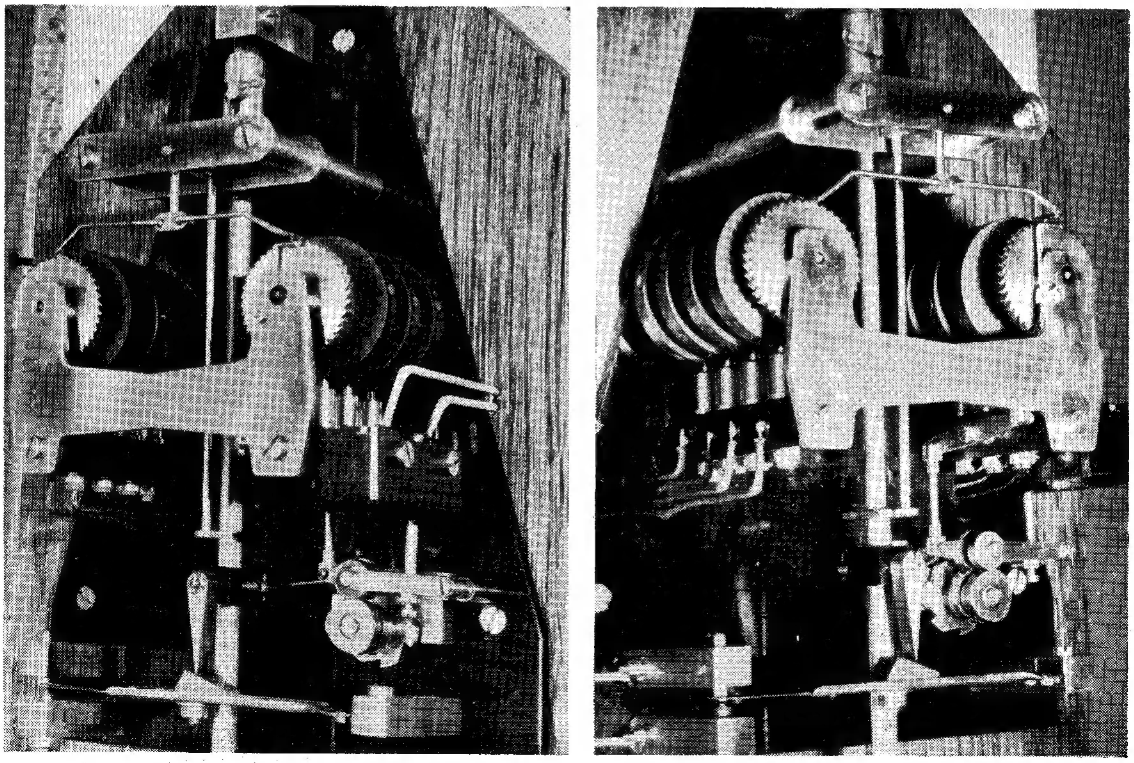
Thanks to the "M.E."

An experimental engineer, Mr. M. H. Cox, acknowledges the help he has received from information furnished, and gadgets described by our contributors

THIS is not really an article on model engineering at all, as the things described in it are not models; it is rather an appreciation, or a way of saying " thank you," to a number of contributors to THE MODEL ENGINEER in recent years. I do not know how many people have found THE MODEL ENGINEER and the information it contains of value in their business, or working capacity, but the number must be large. Frequently, the advertisements are of use; frequently, too, there are bright ideas in the way of machining methods, and " wangles " of various kinds which are of use to someone who may one day be faced by similar problems in his work. The thanks I have to offer, however, are more specific in their nature, as I have deliberately taken designs of contributors and modified them to suit other ends.

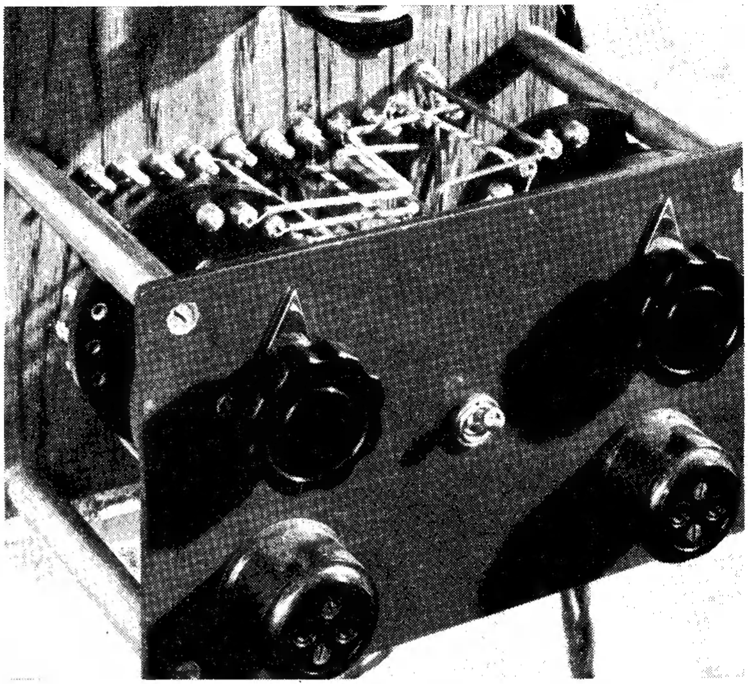
My job is, to my mind, anyway, an unusually interesting one, in that I have to design, and make specialised instruments and small mechanical gadgets for use in the laboratories of a large chemical research department, whose work covers a very wide range of subjects. Often devices are required which are not available on the open market, and, even more often, things are wanted, at short notice, which, though available outside, have such long delivery times, that their purchase is quite impractical. At other times, finance rules that things shall be made rather than purchased. I have no idea how many things have been turned out by my section in the last five years, but I am sure that the design of many of them owes quite a bit to THE MODEL ENGINEER. The three devices illustrated here in particular are, in some respects, almost direct copies, in some part of their make up, of items described in THE MODEL ENGINEER.

My first thanks then, go to Mr. C. R. Jones for his Battery-Driven Electric Clock described early in 1950. I made one of these clocks, with very minor modifications, for my house, where it attracted considerable interest, and has always been most reliable; its time-keeping properties are quite remarkable. It became necessary to produce a timing device for operating a laboratory distillation plant. I should explain here that accurate distillation is not quite like the distillation we did at school, where the distillate trickled out continuously; in this case, the still operates on a reflux system, whereby the



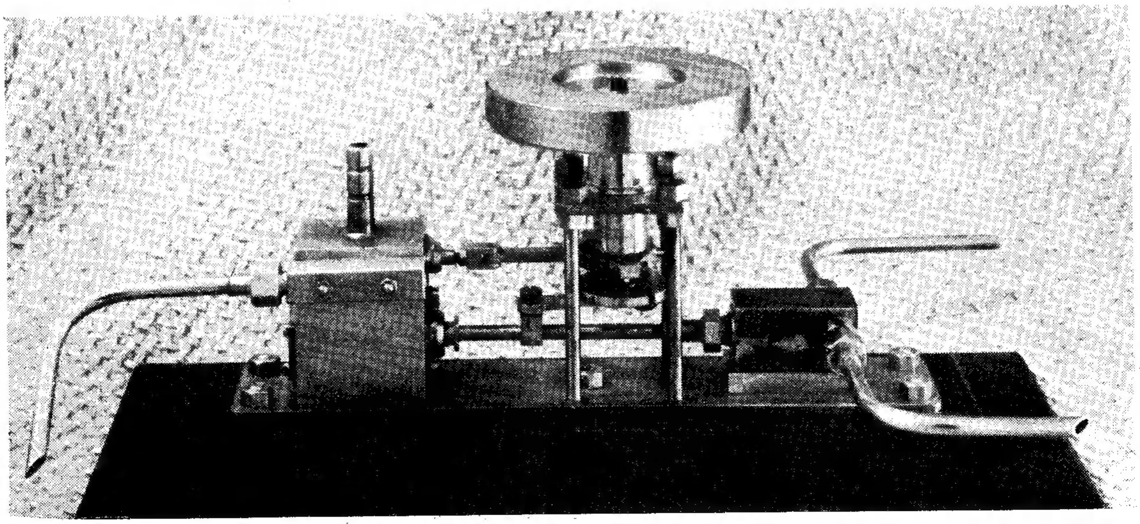
Motion work of timer, showing Hipp gear

distillate runs back into the " kettle " for most of the time, and is only " taken off " for a short time, which allows the still to remain in balance. The ratio of reflux to off-take time is known as reflux ratio, and this ratio must be easily variable according to the stage the distillation has reached. Ratios generally required range from 1 : 1 to 120 : 1. The valve controlling the reflux is normally magnetically operated, therefore the job of the timer is to supply electrical impulses at the required intervals. Usually this is done either by the charging and discharging of a condenser, or by the mechanical operation of contact sets driven by a synchronous motor. In the case in question, the condenser method was not approved by the laboratory, and the mechanical method was chosen. It turned out, however, that the purchasing section were unable to obtain delivery of a synchronous motor in time to suit the needs of the laboratory. By now, of course, the whole problem had become one of *time* rather than *ratio*, and so my mind turned to clocks in general, and the Hipp clock I had made, in particular. A little thought showed that the problem seemed capable of solution in this way, and the photographs show the final answer.

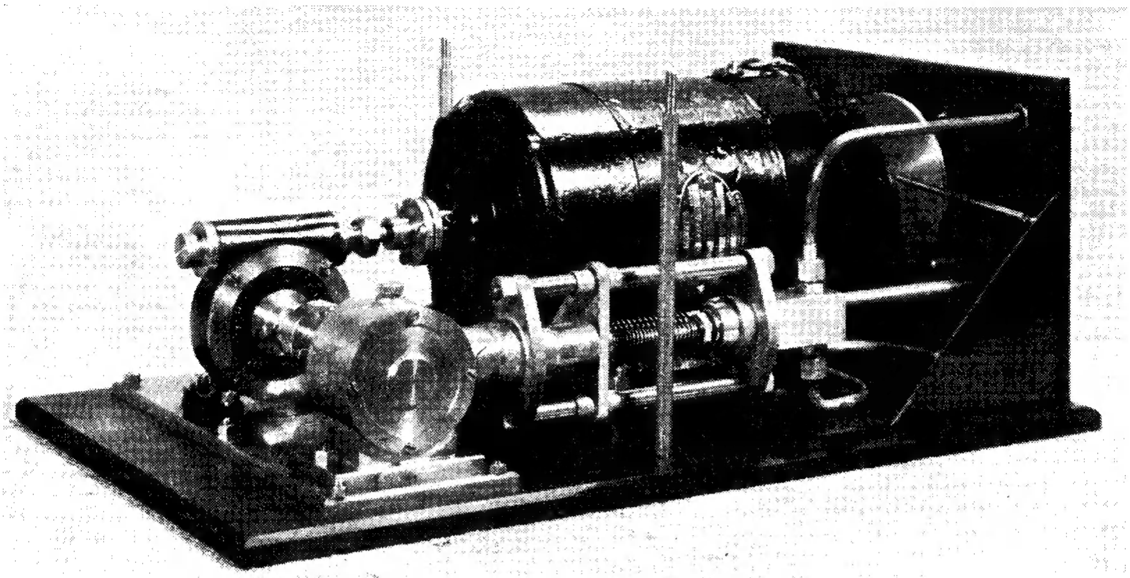


Selector panel for timer

Each swing of the pendulum to the left, rotates the escapement wheel on the bottom right-hand corner of the motion plate, 1/6th of a turn. On the shaft of this wheel is a 3-lobe cam which operates a micro-switch. This switch, therefore, gives " on " periods of $1\frac{1}{2}$ sec., and " off " periods of the same duration. Here then we have a 1 : 1 ratio. Each leftwards swing of the pendulum also rotates the ratchet wheel at the upper left side of the motion plate, one tooth of the 40 teeth on the wheel. The shaft of this wheel carries contact discs, the first having eight contacts, the next four, then two, then one. These contacts are made against brushes carried in spring holders, and are timed to make when the micro-switch is made. One revolution of this shaft takes one minute, so eight " makes," or " on " periods, occur in the minute, the " on " period totalling 12 sec. ($8 \times 1\frac{1}{2}$) and the " off " totalling 48 sec., giving 4 : 1 ratio. The remaining contact discs on this shaft give 9 : 1, 19 : 1 and 39 : 1.



Liquid pump operated by compressed air



The variable stroke pump

The right-hand contact shaft runs at 1/3rd the speed of the left, and this reduction is not achieved by gearing. The escapement wheel shaft carries a second cam having two lobes, and this cam, via a series of push-rods and levers, operates a trip device which holds the pawl driving the right-hand ratchet wheel out of engagement with that wheel for two swings of the pendulum, but allows it to engage for the third. In this way, this contact shaft. takes three minutes for one revolution; therefore, the three contacts on this shaft provide ratios of 29 : 1, 59 : 1 and 119 : 1. Double selection of "makes" of the micro-switch, is prevented by wiring these contacts in series with those on the left-hand shaft, both, of course, being in series with the micro-switch which does all its work of making and breaking while the brush contacts are stationary, this prevents sparking. The selection of ratios is accomplished by the rotary switches at the bottom of the timer, there being two of these for independent operation of two still heads. Operation of both clock and still-head magnets is by 12 V, d.c. current.

Obviously, the pendulum has far more work to do than it had on the original clock, but it seems well up to the job, and times between impulses of the Hipp gear are about 20-30 sec. A second one of these timers was also made, for operating four still-heads, in this case, however, the pendulum merely made a contact each time it swung to the left. The impulses so obtained energise a solenoid which operates a ratchet wheel via a pawl; the high and low speed shafts are concentric, and reduction is by gearing. The same ratios are supplied. This version works well, but, personally, I dislike the noise made by the solenoid operation.

The second gadget, of course, is pure "L.B.S.C." though he might not own the child. In this case, a circulating pump was required for alcohol in an atmosphere with a high oxygen content; anything that might spark was, naturally, frowned upon. Since an air line at 25 p.s.i. was available, in the laboratory, a steam engine running on compressed air seemed obvious. I don't think any enlargement of the theme is required; the engine cylinder is $\frac{7}{8}$-in. bore and stroke, and the pump, if I remember right, $\frac{3}{8}$-in. bore. The crankshaft runs in ball-races, and the valve is a piston valve about $\frac{3}{8}$ in. diameter. The pump is one of "L.B.S.C.'s" boiler feed pumps, so far as its internals go, but the balls are lightly spring-loaded, as they lie in the horizontal plane. Lubrication would probably amuse many people; the air supply pipe dips between the tap on the main feeder line and the engine, connection to the feeder being a short length of rubber tube. Every morning the rubber is removed from the tap, and a few squirts of oil injected into the pipe. It may be crude, but it works; the engine has run for $2\frac{1}{2}$ years now without trouble. The little-end knocks a bit, but the piston and cylinder seem as good as new. The pump, incidentally, is always covered with $\frac{1}{2}$ in. or so of hoar-frost, as the alcohol temperature is anything down to -70 deg. C.

The third item is again a pump, and again my thanks go to "L.B.S.C." In this case the pump is electrically driven by an induction motor through 25 : 1 reduction gear, and the pump is operated by a crank running in an oil bath crankcase. The return stroke of the pump is restricted, by an adjustable stop, the pump, therefore, being of the variable stroke type. The ram has a diameter of $\frac{1}{8}$ in., and both valves are of the double ball type—two valves in series, if you like. The particularly interesting part about this pump, to my mind, is its performance on test. It pumped continually, against a lift of 3 ft. and a head of 10 ft., a delivery of one drop per 57 sec., this being maintained without variation for several hours. The pump stroke on this test was less than 1/64 in. Maximum delivery, on full stroke, is 630 c.c./hr., and has maintained accuracy over the two years it has been in use, within 1 per cent. In that time only packing glands have been replaced on the pump, though at least one motor has had to be replaced, due to the worm reduction seizing solid overnight. The indicator dial on the front panel has been calibrated, and provides a reasonably accurate indication of the output. Normally, the pump is in service working against a 10-foot head, but it has been used against a 200 lb./sq. in. pressure.

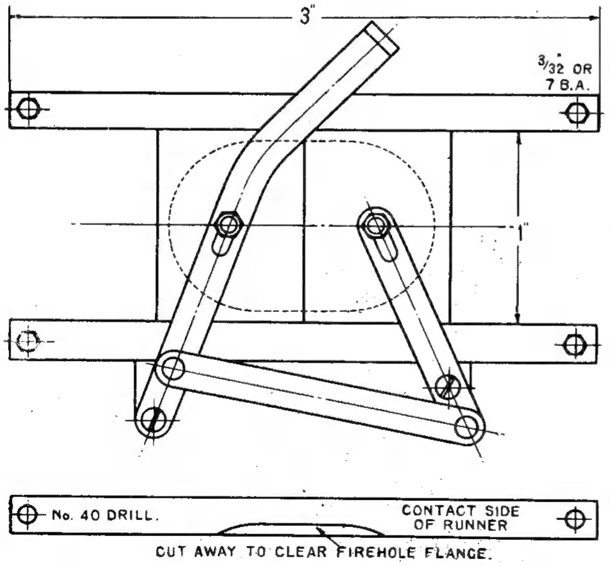
L.B.S.C.'s "Britannia" in 3½ in. Gauge

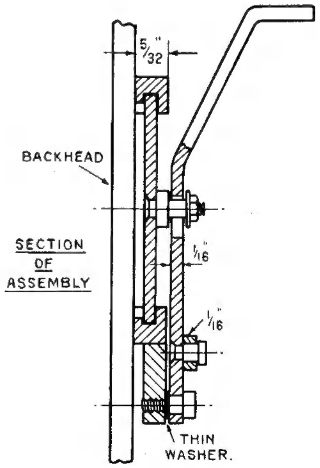
● DETAILS OF BOILER MOUNTINGS

ON the full-sized engines, the "Tritone" chime whistle is mounted on the side of the smokebox and connected to the end of the operating rod that stretches across the backhead, by a wire cable going through the handrail. If our "scale" experts made a slavish copy of this, it might produce the same sort of sound that you might hear if you stood at the end of the departure platform at Liverpool Street, and listened to the three blind mice of the nursery rhyme, squeaking on the platform at Ipswich—that is, if the "scale" cable in the "scale" handrail didn't break; which just goes to show how ridiculous the idea is. Anyway, we shall be using a real "Casey Jones" chime whistle, with a normal-sized valve to operate it; and to allow it to be operated by a gadget similar to that on the full-sized engines, I have arranged the valve to go between the backhead and the cab side, as shown in the illustrations published with the last instalment of this serial.

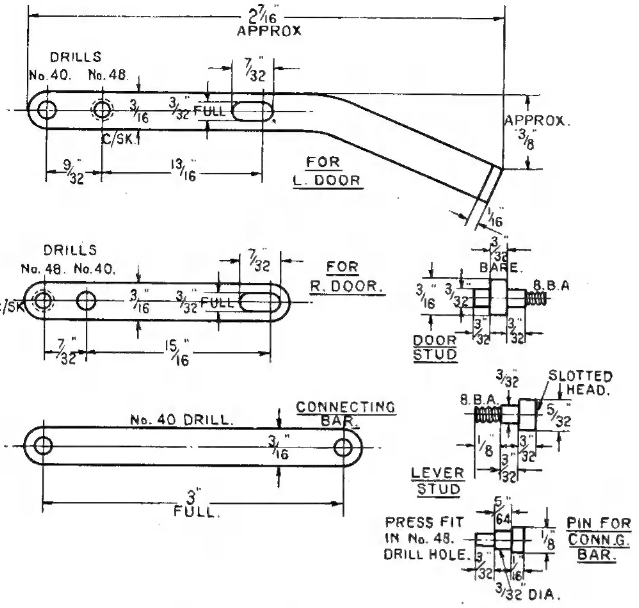
To make the valve, part off a piece of $\frac{5}{16}$-in. round rod a bare $\frac{13}{16}$ in. long. Chuck in three-jaw, centre, and drill right through with No. 34 drill. Open out and bottom with $\frac{3}{16}$-in. drill and D-bit to $\frac{5}{16}$ in. depth, and tap the end 7/32 in. × 40, slightly countersinking. Reverse in chuck and repeat operations, but drill to $\frac{3}{8}$ in. depth, and don't use the D-bit. Put a $\frac{1}{8}$-in. parallel reamer through the remains of the No. 34 drill hole. At 7/32 in. from the D-bitted end, and $\frac{1}{4}$ in. from the other end, drill $\frac{3}{16}$-in. holes exactly opposite, as shown in the illustration; fit a $\frac{1}{4}$-in. × 40 union nipple in the former, and a 7/32-in. × 40 union nipple in the other one. Fit a little angle-bracket as shown in the end view, and silver-solder the lot at one go. Pickle, wash off and clean up, then fit a hollow cap, with ball and spring as shown, to the D-bitted end. At the other end, fit a slotted cap, same as I specify for ordinary whistle valves. This is drilled No. 48 for a 15-gauge bronze or brass push rod. The length of the head is $\frac{5}{16}$ in. overall, the slot being a full $\frac{1}{16}$ in. wide and $\frac{1}{4}$ in. deep. File to the shape shown, and fit a $\frac{1}{16}$-in. stop pin to it, to prevent the lower part of the bell crank jumping out and letting the push rod loose. The push-rod should project a bare $\frac{1}{16}$ in. in the slot, when the inner end is resting against the ball; see sectional illustration. Don't attach the valve permanently to the side of the firebox until the shaft and levers have been fitted.

The cross-shaft is a 4-in. length of $\frac{1}{8}$-in. round steel, with a $\frac{1}{16}$-in. pip turned on each end, $\frac{1}{16}$ in. diameter. It is carried in two brackets, which are easily filed up from $\frac{1}{8}$ in. × $\frac{1}{4}$ in. flat rod, to shape and dimensions shown. Drill the boss No. 30, and the screw-holes No. 48. The handle at the valve end (right-hand end) looks like a baby boomerang, and the other is just a plain lever, same shape as the upper part of the boomerang. Thread the brackets or bearings, on the shaft, squeeze on the handles, and silver-solder them. The complete assembly is attached to the backhead by two 9-B.A. screws in each bracket, in the position shown in the illustration of the complete backhead in February 12th issue, the centre-line being approximately $2\frac{3}{8}$ in. from the top, and the boomerang about $\frac{1}{4}$ in. away from the side. The right-hand bracket should be about $\frac{3}{8}$ in. from





Details of sliding type firehole doors



Levers, studs and pins for sliding doors

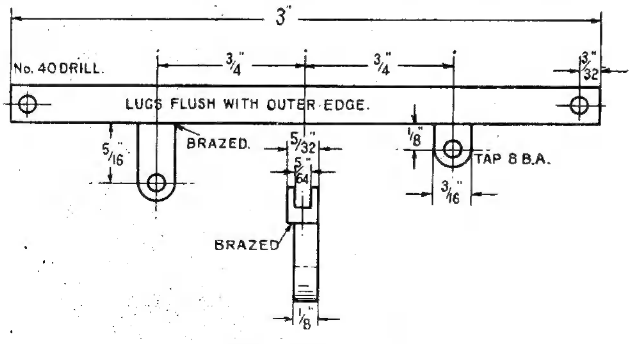
the edge. When you have it fixed, set the whistle-valve under it in such a position that the vertical arm of the boomerang fits into the slot, and just touches the push-rod, as shown in the sectional illustration. The spindle can, of course, be adjusted laterally in the brackets, to suit the position of the valve; and the whistle valve can then be attached to the side of the firebox by a 6-B.A. brass screw. Solder over screw and bracket, same as the firebox stays, which will prevent leakage for all time. Finally, connect the upper union to the right-hand one nearest the end of the manifold, by a $\frac{1}{8}$-in. copper pipe, preferably thin-walled, furnished with union nut and cone at each end. This pipe should lie as close to the firebox as possible. The valve should operate easily by a mere touch on the lever at either end. The actual whistle cannot be fitted until the engine is nearly completed, so there is no need to bother about that yet!

Sliding Firehole Door

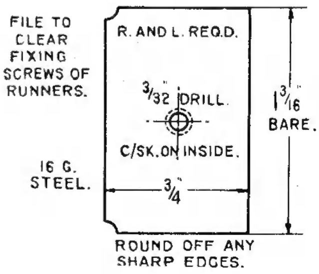
In response to the lads of the villages who wouldn't give me any peace until I promised to describe a sliding firehole door, here is the needful; and if the bottom runner becomes choked with coal dust, and the blessed doors won't shut, don't get blaming Curly! The two runners are made from 3 in. lengths of 5/32 in. × $\frac{3}{16}$ in. steel (brass would do, as the backhead is painted) or $\frac{3}{16}$ in. square rod can be used, 1/32 in. being filed or milled off one side. If you file it, put the filed side next the firebox. Each has a groove 3/32 in. deep and 5/64 in. wide (make it 3/32 in. if you like) milled for the full length, in the middle of a narrower side. Failing a regular milling machine, the easiest way to cut the grooves would be with a saw-type cutter on a spindle between centres, and the rod held in a machine-vice (regular or improvised) at the correct height, the vice being bolted to the lathe saddle, or cross-slide. The runners could also be built up from three strips silver-soldered together, a $\frac{3}{16}$-in. strip at each side with a 3/32-in. strip in the middle. When these are screwed to the backhead at 1 in. apart, it will be found that the flange of the firehole door fouls them; so a piece of the runner next to the firebox, must be milled away to clear, as shown in the detail sketch below the door assembly.

The Runner Lugs

The lower runner needs two lugs fixed to it, for carrying the studs on which the levers work. These are shown in another detail sketch, and are made from $\frac{1}{8}$ in. × $\frac{3}{16}$ in. flat rod. They can be held in position with temporary home-made cramps (I often make these from odd bits of steel, and stove screws, to suit any special job; they only take a few minutes) and brazed or silver-soldered in position. After cleaning up, tap each for the studs, as shown. Each runner is then drilled No. 40 at each end, and fitted to the backhead by 3/32-in. or 7-B.A. screws. Make these yourself, from good quality phosphor-bronze, either round or hexagon, as desired. Steel screws rust, and brass screws rot. Rustless screws can be used if preferred—but be sure they ARE rustless! Don't attach the upper one permanently yet. Note—the bottom of the groove in the lower runner may, if you like, be cut clean out about $\frac{1}{4}$ in. each side of centre, which minimises the chance of the doors not coming close together through coal dust in the groove.



The bottom runner



Sliding door

Working Parts

The doors are made from 16- or 18-gauge sheet steel, and are $1\frac{3}{16}$ in. high and $\frac{3}{4}$ in. wide, one top and bottom corner being filed to clear the fixing screws on the runners. Drill a 3/32-in. hole in the middle of each ; and in it, fit a stud made from $\frac{3}{16}$-in. round steel rod as shown. Detailed description of these small turning jobs isn't needed ! Countersink the hole in each door, hammer the end of the stud into the countersink, and file flush, as shown in section.

The two levers and the connecting bar are cut from $\frac{3}{16}$ in. $\times$ $\frac{1}{16}$ in. steel strip, to the shapes and sizes given in the illustrations. Be careful with the drilling and countersinking, or the holes may be changed over, and the countersinks on the wrong side—it's easily done ! Note the slotted holes ; they are needed, as the levers move in an arc, and the doors in a straight line. Next, turn up two slotted-head lever studs, and two pins for the connecting bars, as shown among the details ; ordinary mild steel is quite good enough. The levers and connecting bar can then be assembled. Attach one end of the connecting bar to the middle hole in the long bent lever, and the bottom hole in the short straight lever, by aid of the turned pins, riveting the stems into the countersinks and filing flush. These joints should be absolutely free, to ensure easy operation when the engine is running.

Erection

To erect, remove top runner, and put the doors in place ; they should slide quite freely when the runner screws are tightened up. Now put the lever assembly in position, with the slots over the door studs, and attach the lower ends of the levers to the lugs under the bottom runner, by aid of the turned studs. When same are screwed in tightly, the levers should work quite freely. Finally, put a couple of 8-B.A. commercial nuts and washers on the door studs. You should be able to flick the doors open and shut with the shovel blade, when firing the engine on the road ; that is, as long as the runners are clear !

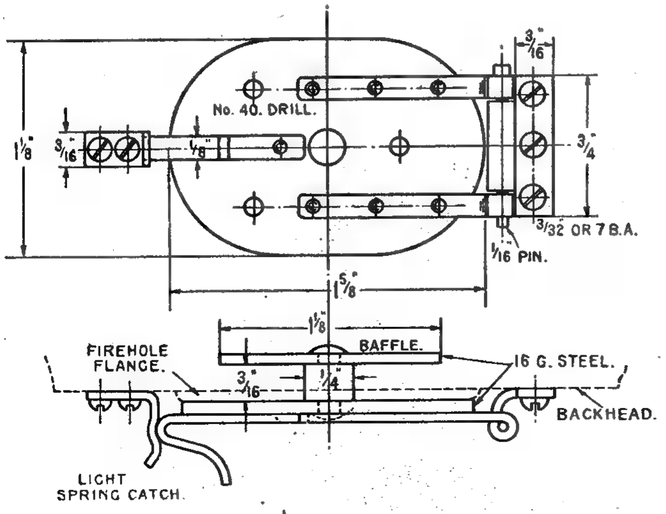
Swing Door

For those who prefer it, I have added a drawing of a suitable swing firehole door, and it is hardly necessary to add that I shall use this type of door on my own engine, as all the rest of the fleet have them, and they give no trouble whatever. Our approved advertisers will probably be able to supply castings for both door and hinge ; but if not, the door is easily built up. The door itself is an oval of 16-gauge sheet steel, measuring $1\frac{1}{8}$ in. $\times$ $1\frac{5}{8}$ in. ; check this from the overall size of your firehole flange, which it should just cover. The baffle plate is made from similar material, but should be an easy fit in the firehole ; make it, say, $1\frac{1}{8}$ in. $\times$ $\frac{5}{8}$ in. The hinges are similar to those on the smokebox door, but they needn't be such a posh job ; they could be cut from 18-gauge steel strip, $\frac{1}{8}$ in. wide, bent into a loop at the end, and brazed. Rivet them to the door, as shown ; ends of domestic blanket pins make nobby rivets for jobs like these, when commercial rivets aren't available. On several of my own engines, I haven't bothered about separate hinge straps at all ; merely left a couple of lugs on the edge of the door, when cutting it out, and bent them around to form the eyes. The handle, which also forms part of the catch, is made from similar material, and fixed in a similar manner.

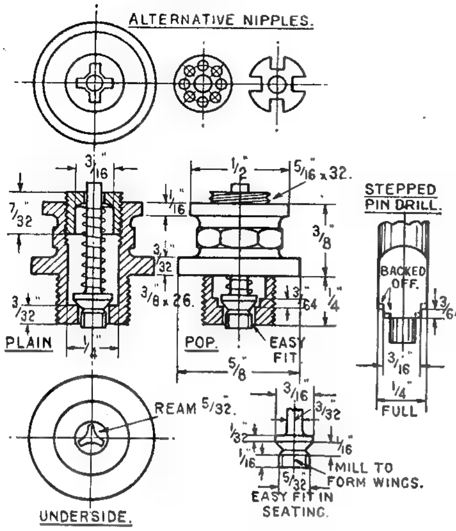
Door and baffle are drilled No. 30, right in the centre of each, to take the $\frac{1}{4}$-in. stud, $\frac{3}{16}$ in. between shoulders. The ends of the stud, or distance-piece, are pushed through the holes and riveted over, as shown, keeping the two ovals fair with each other. Three air holes are drilled as shown, using No. 40 drill ; these aid combustion, and prevent smoke at the chimney. Some folk, especially kiddies, like to see smoke coming from the chimney, but Curly doesn't ! We were taught on the L.B. & S.C.R. that smoke from the chimney meant bad combustion and waste of coal ; British Railways haven't learned that lesson even yet—unless the Coal Board dishes them out with their precious "nutty slack," which has the reputation of being the exception to the rule "No smoke without fire, as an M.P. recently said in the fire." It is just all smoke and no the House ! The lug for the hinge can be made by cutting a piece of 18-gauge steel $\frac{3}{4}$ in. wide, and cutting back the top and bottom, $\frac{3}{16}$ in. from the end, to form a tag, which is bent to the same radius as the hinge eyes, see plan. There is no need to braze it ; the bend will "stay put" without. The pin is made from a bit of $\frac{1}{16}$-in. steel wire, with a head brazed or silver-soldered on ; or it may be screwed on, if you wish.

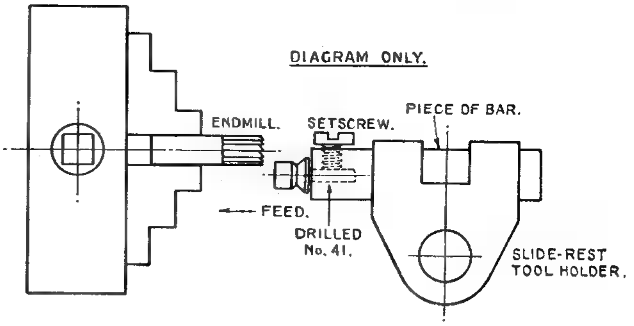
Materials

Drill three No. 41 holes in the flat part of the lug, and attach it to the boiler backhead by three 3/32-in. or 7-B.A. screws. Again, don't trust commercial screws, either brass or steel, for this job, or the door may fall off when running. Make your own screws from good drawn phosphor-bronze. The catch spring can also be made from this metal ; I use a bit of the same kind as used for brush springs on dynamos and motors, so Milly Amp has a "finger in the pie." Incidentally, old Father Neptune has come ashore and assisted with my own *Britannia* ; the piston-valve liners are turned from a bit of Admiralty bronze, that was once part of the propeller shaft of a steam launch ! Lovely stuff it is, too ; nice to turn, excellent finish, and absolutely flawless. Bend the



Swing type firehole door





How to mill wings in safety-valves

Left—Details of safety-valves

bit of bronze strip, or steel strip if you prefer it, to the shape shown in the plan view, and attach to the backhead by two more bronze screws. The catch shouldn't be stiff; it only needs enough spring to hold the door closed, and should be light enough to allow the door to be opened easily with the shovel blade.

Safety-valves

The safety-valves were another minor problem. "Scale" safety-valves would have been useless to relieve the boiler pressure, as anybody who has had experience of the way Curly boilers steam, will readily confirm. At the same time, they couldn't be much bigger without being clumsy and unsightly; so I effected a compromise by making their bodies a little more "ombompong," and letting the valves seats down into the bases, same as I did on *Tugboat Annie*. Her valves work all right. Builders can please themselves whether they use pop valves or plain valves; the only difference is in the shape of the seating. The pop valve has a stepped seating. Our approved advertisers may make castings for the valve bodies, with the hexagons cast on, so that they only need smoothing with a file, after the machining has been done. Otherwise, use ⅝ in. round rod. Chuck in three-jaw, face the end, centre, and drill down about ¾ in.
.152 depth with No. 24 drill. Turn down ¼ in. of the outside to ⅜ in. diameter, and screw ⅜ in. × 26, to suit the boiler bushes. Part off at ⅝ in. full from shoulder, then repeat operations for the second valve.

Chuck by the thread, in a tapped bush held in three-jaw, and turn the outside to the profile shown, leaving a ⅛ in. collar in the middle, which is filed to a hexagon shape; a job easily done, if the file is held horizontally, and the chuck jaws used as guides. Open out the centre hole with ¼-in. drill and D-bit, to a depth of 17/32 in.; slightly counterbore the end for about ⅛ in. down, and tap 5/16 in. × 32 or 40. Put a 5/32-in. parallel reamer through the remains of the No. 24 hole. This body will be all right for the plain type of valve. If pop valves are desired, the body will have to be opened out with a stepped pin-drill. I have given detailed instructions for making these, several times. Briefly, it is just an ordinary pin-drill, with steps filed in the cutting edges before hardening; or the steps may be turned before the end of the drill is filed flat. The latter is what I do when making them, as it gives more accurate results. In the present instance, the main part of the drill is ¼ in. wide, with a 3/16 in. step, 3/64 in. deep, between the full width and the pilot pin, which should be an easy fit in the No. 24 hole. The drill should be entered into the valve body until the lower cutting edge is 3/32 in. from the bottom. The upper part is counterbored and tapped, in the same way as the plain valve.

The valve nipple is just a 7/32 in. length of 5/16-in. round rod, screwed to fit the valve body, drilled No. 40 and counterbored to allow the extra length for the valve spring; see section. Steam can be let out in three ways, viz. by filing four slots in the screw threads; by drilling a ring of 1/16-in. holes all around the centre hole where the pin comes through; or by cross-nicking the centre hole. The valve itself can be turned up from a bit of ¼-in. drawn bronze rod. Chuck in three-jaw, and turn down about 3/16 in. length to 3/32 in. diameter; part off at 5/32 in. full from shoulder. Reverse in chuck, and very carefully indeed, turn the valve part to the shape and dimensions shown in the detail illustration. The bottom part must slide quite easily in the reamed hole in the valve body. The angle can be turned with a front tool ground off at the corner; I keep one permanently mounted on each of my tool turrets, and find it very useful for chamfering hexagons on union nuts, and similar jobs. Note that a clearance is formed under the angle of the valve, so that the latter gets a fair bearing on the valve seating. It might be worth the while of an inexperienced turner to grind the end of the tool at an obtuse angle (the exact degree doesn't matter, as the valve forms its own seating) which would form the angle and recess at the one cut. If the tool chatters, just pull the lathe belt slowly by hand; that will teach it good manners.

Forming Valve Wings

All we now need, is to form wings under the valve, and this is another "easy-when-you-know-how" job. Flats could be filed, of course, as specified for *Invicta's* valve, but big valves are usually winged, and it allows more room for steam to

(*Continued on page* 384)

BRITISH CRAMPTON LOCOMOTIVES

By E. W. TWINING

PART 2

CONTINUING the list of Tulk and Ley Cramptons, the London and North Western engine, Lowka Works No. 12, is next to be dealt with. This was the well-known rear-driver single named *London*, built in 1847, for the Southern Division for working between London and Birmingham.

From the side elevation drawing (Fig. 4) it will be seen that the general arrangement was that of an enlarged edition of the other Tulk and Ley six engines. The driving wheels were 8 ft. in diameter, carrying wheels 3 ft. 9 in. diameter. The cylinders had a bore of 18 in. by 20 in. stroke. The wheel base was: leading to centre axle, 7 ft. 6 in., centre to driving axle 6 ft. 6 in. The boiler barrel was of double segmental form of shape as indicated by a dotted line in the end elevation (Fig. 5), with a barrel having a vertical diameter of 4 ft. 8 in. and horizontal, 3 ft. 10 in. and strengthened by a row of centre cross-stays.

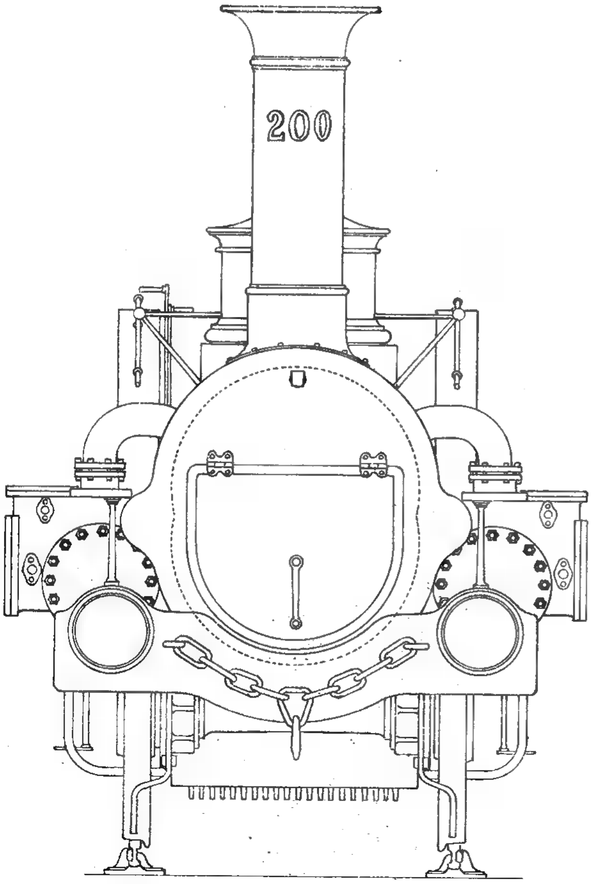


Fig. 5. Front elevation of Crampton engine, "London," 1847

Heating Surface

With regard to heating surface, the late E. L. Ahrons, in his book *The British Steam Railway Locomotive*, 1825-1925, gave the total surface as 1,529 sq. ft. and grate area as 16 sq. ft., but in an early volume of the *Locomotive Magazine*, it is stated that the added areas of tubes and firebox was 1,350 sq. ft. and grate area 21½ sq. ft. The number of tubes was 229, each of 2 in. diameter, and these are said to have been 12 ft. long. The area yielded by these would be 1,438 sq. ft. which, added to 91 sq. ft. in the firebox, certainly confirms Mr. Ahron's figures, but the stated length seems to be in excess of what the measurement between the tube plates could have been. By careful measurement the present writer finds that the grate area must have been 17.87 sq. ft. from which he is of the opinion that the lower value figures for both heating surface and grate area are the more nearly correct. Possibly the heating surface of 1,350 sq. ft. was based on calculations for the fire side of tubes and firebox plates; not on the water side.

Boiler Pressure

The working pressure in the boiler of *London* was just double that of the six seven-feet engines, namely 100 lb. per sq. in. The total weight was, in working order, 25 tons 12 cwt. of which 11 ton 14 cwt. rested upon the drivers, 8 tons 3 cwt. on the leading wheels and only 5 tons 15 cwt. on the intermediate carrying wheels. Thus was arrived at a load distribution which was Crampton's ideal and which eliminated entirely the unpleasant and dangerous pitching motion which was inherent in the design of many other standard

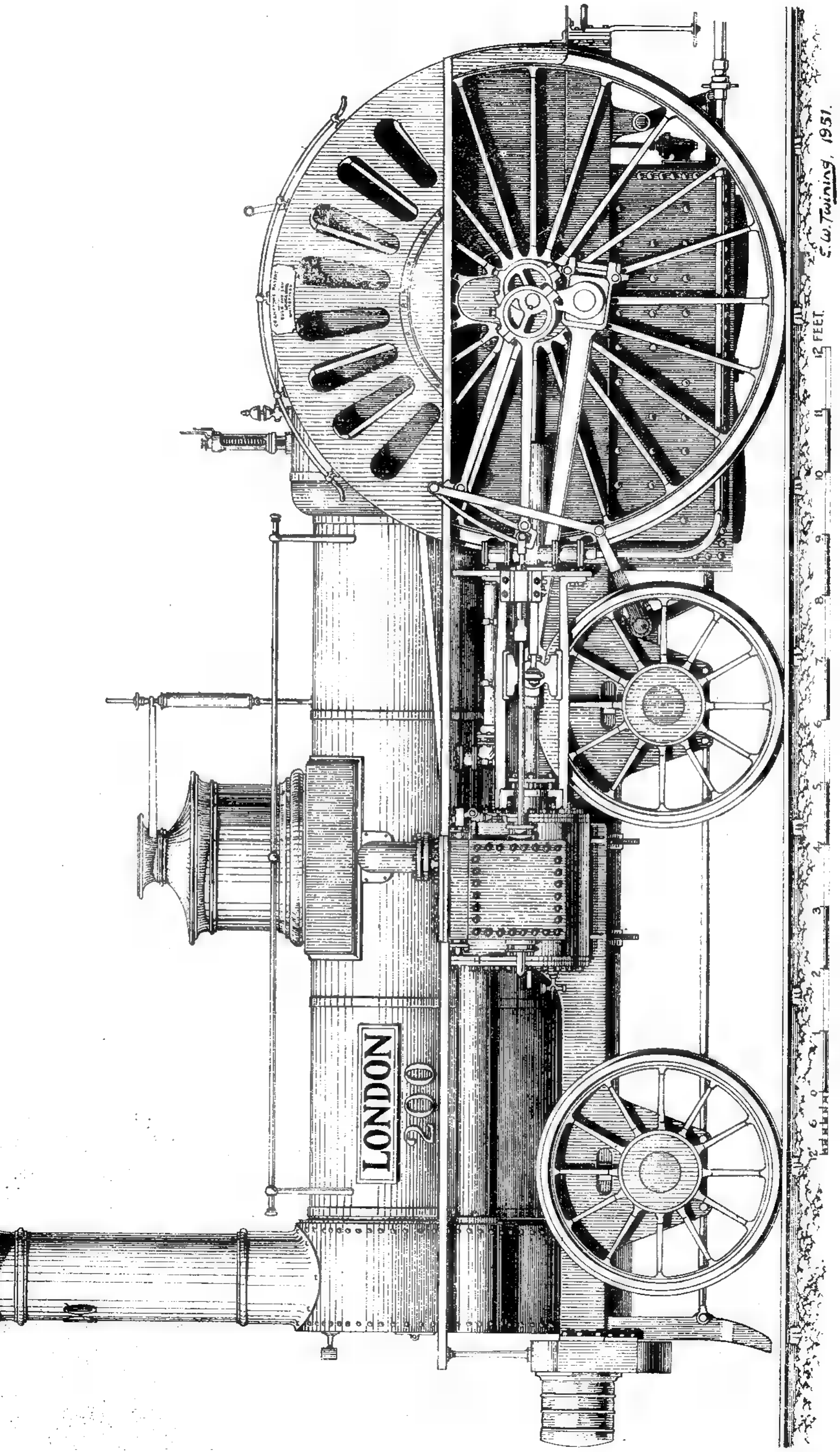


Fig. 4. The L. & N.W.R., Southern Division, Crampton engine "London," 1847

gauge engines of this period; particularly the majority of the standard 2-2-2 type and most of all in the Stephenson "long boiler" engines in which all the wheels were in front of the firebox. Many of these, with their great overhang at each end, were notorious, not only for vertical pitching but for horizontal oscillation, or nosing, as well, which was sometimes responsible for derailments and was a source of terror to some of their drivers who, as a consequence restricted their speeds.

Unpopular

There was one characteristic about the stern-wheel Cramptons which rendered them unpopular with the generality of engine men, at any rate in this country; they were hard riding engines. This is of course what one might expect on a footplate placed over the points of contact of the driving wheels with the rails, where the greatest load was carried. Nevertheless, it is noteworthy that one engine crew was attached to and drove the *Kinnaird* on the Dundee, Perth and Aberdeen line for many years, and it is presumed that these men, with Scottish hardihood, became used to the vibration.

Before leaving these early Tulk and Ley Cramptons a few words may not be out of place regarding certain unusual features; for instance, there were separate regulator valves to each cylinder and these were in boxes over each valve-chest; they were operated by long rods from a shaft, crossing the firebox-back, below the driving spring bracket. To the right-hand end of the shaft the driver's handle was attached.

Demonstration Trials

The *Namur* and *Liege*, before being despatched to Belgium, ran trials, probably of a demonstration nature, on several English railways, and the late David Joy—the inventor of the well-known Joy valve-gear—recorded in his diaries that one regulator shut off before the other. Whether this was intentional seems very doubtful although he said, that "one rod was longer than the other." If this was so, it must have been a mechanical fault which would doubtless be corrected before shipment.

The reversing gear on these engines must have called for a considerable amount of hard thinking over the drawing-board and the result was not perhaps the best arrangement that could have been devised; the reversing arms from the shaft to the long lifting rods to the expansion links, were each twice cranked at right-angles, which must have put on the middle portion, which was of considerable length, a high torsional, as well as a bending, stress; especially in the *London*, in which the outer end was longer than in the six 7 ft. engines.

The steam-pipes, between the boiler and the valve-chests, were, at first, unlagged though the *Kinnaird* photograph shows that they were later cased in.

There were three safety-valves; two on the dome with Salter spring balances and one, direct loaded on the firebox with scales to indicate the pressure at which the valve lifted. One of the Salter balances was also provided with a scale and pointer.

Boiler feed pumps, one on each side of the engine, were mounted between the connecting-rods and the valve-gears and were driven off the crossheads.

"BRITANNIA" IN $3\frac{1}{2}''$ GAUGE

(*Continued from page* 381)

escape. Drill a No. 40 hole in any bit of bar that will go under the slide-rest tool holder; if you put the drill in the three-jaw, and the bit of bar in the tool holder, the hole will be drilled at the correct height by feeding the bar on to the drill. Fit a set-screw as shown, put the valve pin in, see that the set-screw is perfectly tight, and then feed the valve on to a small end-mill ($\frac{1}{4}$ in. or $\frac{5}{16}$ in.) held in three-jaw. Adjust cross-slide for depth of cut, and feed the valve into cut, by turning the top-slide handle carefully. Slack the set-screw and turn the valve around one-third of a turn, to cut the second and third segments. The diagram will probably give readers a better idea of how to do the job, than yards of explanatory rigmarole. The valve can be ground in by smearing a taste of carborundum powder and oil, or a scrape off your oilstone, on to the angle, putting it in place, and screwing the nipple right home, which will allow enough of the pin to project for turning purposes. A couple of inches of copper tube pushed tightly on the projecting bit of pin, makes a nobby extension handle for the job. Only a few turns will be needed, provided that valve and seating are true. Twirl the valve back and forth, same as when grinding valves in a gas buggy engine. Finally, wash off all the abrasive and assemble the valve as shown, with a spring wound from 22-gauge tinned steel wire, which should have both ends ground off square, and just start to compress as the nipple enters a couple of threads.

I test my safety-valves on a brass container with an air pump and full-sized steam gauge attached. If a pop safety-valve doesn't reseat quickly, and allows a considerable drop in pressure before it shuts, the top part is too good a fit in the recess, and a very slight skim should be taken off it; it is merely a question of trial and error, to get a quick shut-down, with only two or three pounds' pressure drop. Patience is a virtue! Next stage, top clacks and other fittings.

Tail Lamp

Just before the war, when holding a post-mortem on a locomotive boiler with a collapsed crown sheet, I found that the crown had originally been stayed to the wrapper by round vertical rods, which had wasted away in the middle, from $\frac{3}{16}$ in. diameter to about $\frac{1}{16}$ in. The pressure on the firebox crown had snapped them. This wastage is the reason I specify girders, which do not deteriorate any more than the metal of the boiler. As rod wastage seldom occurs within a $\frac{1}{4}$ in. of the plates, firebox stays obviously are little affected; but if these are silver-soldered the ends become brittle and are liable to fracture easily. Longitudinal rods waste but little, as they are not connected to the firebox and are never above water temperature. Experience teaches!

MORE SPEED

Railway enthusiasts were pleased to learn of the speeding up of many express passenger trains this summer. From the point of view of the railway traveller, this improvement is long overdue; but there have been reasons for the delay in bringing it about, and the chief of these is the difficulty that has been experienced in repairing the effects of the extremely heavy traffic borne by the railways during the war.

At last, however, practically all our main lines are again in first-class condition; hence the programme of accelerations that is to be brought into operation this summer.

Making a Shooting Stick

By J. R. Bedford, M.Coll.H.

REFERRING to the drawing (Fig. 6), a line can be struck $1\frac{1}{4}$ in. from the base curve and the pads sawn off. The recess may be sawn out next and then filed to shape. The $\frac{3}{16}$ in. holes can be marked out and carefully drilled from each side and finally reamed to finished size.

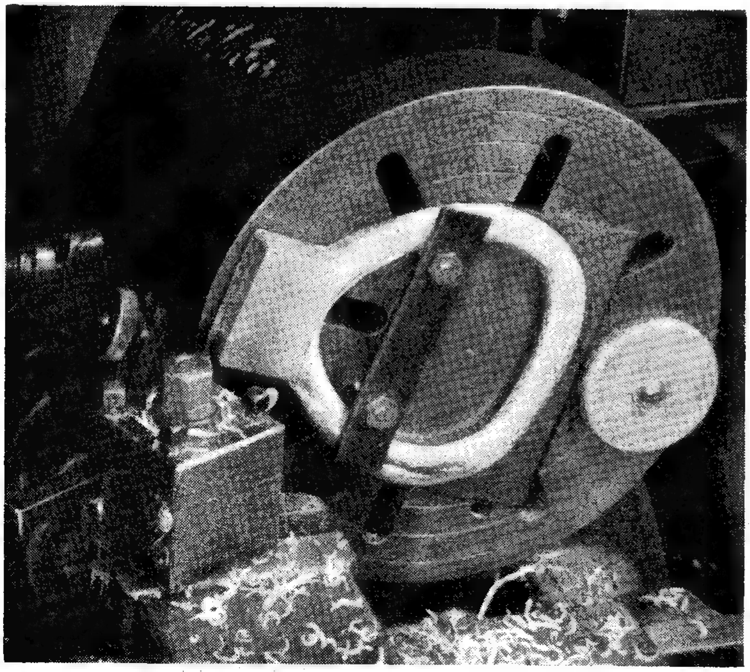
These slots are usually made the same size as the the head, depending on a close fit to provide the necessary friction to keep the handles in place and to prevent them "flopping" about. It is felt that a better job will result if fibre washers are inserted here; provision has been made in the drawings for these.

The dowel holes can now be marked out in the head. To do this, set the point of the scribing block $\frac{3}{16}$ in. above the surface plate and scribe along the sides of the body and along the top edge on the front and back faces only; i.e., those which have been left square. Centre-punch a few thou. inside the marks so obtained, this is to make sure that, when drilled and assembled, the dowels will hold the handles hard against the sloping sides and will not allow them to fall below the horizontal, this is a most important point. Take each handle in turn and fit it in place looking through the $\frac{3}{16}$ in. holes as a final check on the positioning of the centre-punch marks in the head. If all is well, drill half way through from each side with a 5/64-in. drill, opening out with a $\frac{3}{16}$-in. drill and reaming to finished size. The top corners of the head can now be radiused, the dowels made and the handles carefully fitted. A useful tip here, culled from the bitter experience of the years, is that, when fitting this type of joint, it helps to use dowels a couple of thou. down on size and use only the full size dowels on the final assembly.

The handles and body can now be given a final polish on the buffing wheel and assembled. This is quite straightforward, provided the fitting has been done carefully. Don't forget to round off and highly polish the end of the dowel that is to enter the hole first. Oil well, and a little gentle persuasion from the mechanic's friend, the hammer, will do the trick. The resultant job should be looking something like the photograph of the finished stick, which appeared with the first part of this article.

The head assembly and the spike may now be fastened to the stick. There are many ways of doing this. In the model shown, the stick was left on the big side so as to give an interference fit, it was then greased and "persuaded" home. It

Concluded from page 350, *March* 19, 1953.



Photograph No. 8. Handle clamped to faceplate, with packing underneath

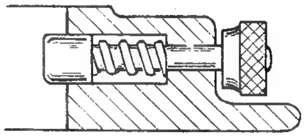


Fig. 4. Section through disc, showing spring-loaded pin

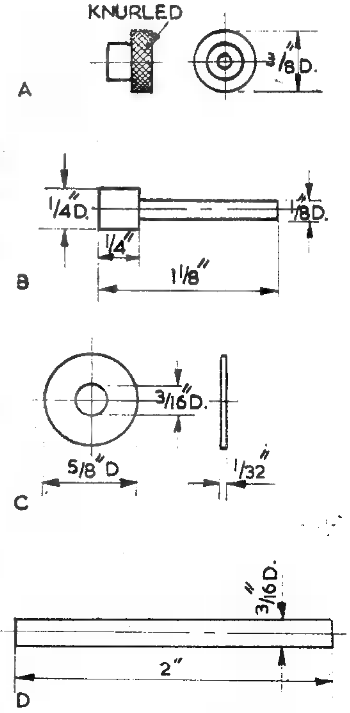


Fig. 5. A : Brass knob—1 off ; B : Brass pin—1 off ; C : Fibre washer—4 off ; D : Brass Dowel pin—2 off

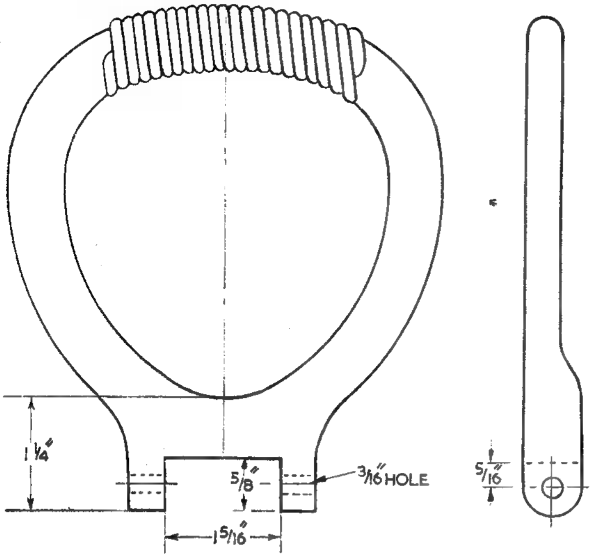


Fig. 6. The handle

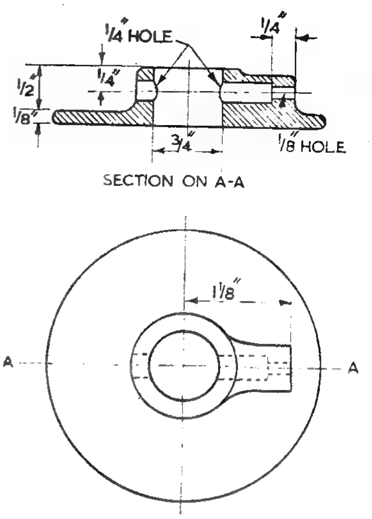


Fig. 7. The disc

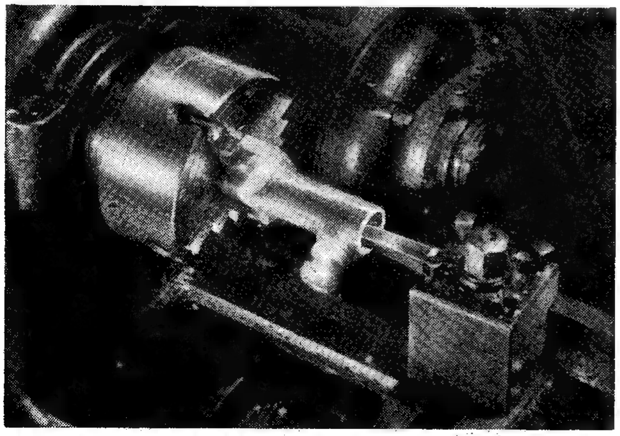
has stood up to 12 months' hard wear without showing any signs of coming loose. Perhaps one point worth noting here is that the stick should be thoroughly dried out before machining, as wood readily swells and shrinks in sympathy with the moisture content of the atmosphere. Another method is to cross-drill, say $\frac{1}{8}$-in. through the assembled casting and stick, then fitting a dowel pin and filing the ends off flush. Or it can be fox-wedged, that is, the stick can be sawn across the end to take wedges as in a hammer handle. The wedges are then fitted and the stick driven into the casting, the wedge striking the bottom of the hole first, and so expanding the stick inside the hole.

The remaining piece of work is the disc (Fig. 7). This is clipped on the bottom of the stick when it is used on soft ground, and when not required, is carried out of the way on the peg at the side of the body. Hold in the 3-jaw chuck as mentioned earlier and turn the face slightly concave. Round off the edge and turn as far across the back as possible. Drill and bore the $\frac{3}{4}$-in. hole and part off to length. A wooden peg in the vice will hold the disc whilst it is filed to shape and polished. The hole for the plunger should be drilled as shown, and the plunger, pin, spring and knob assembed as shown in Fig. 4. These are assembled from the inside, the final operation being the soldering of the knob on the end of the pin.

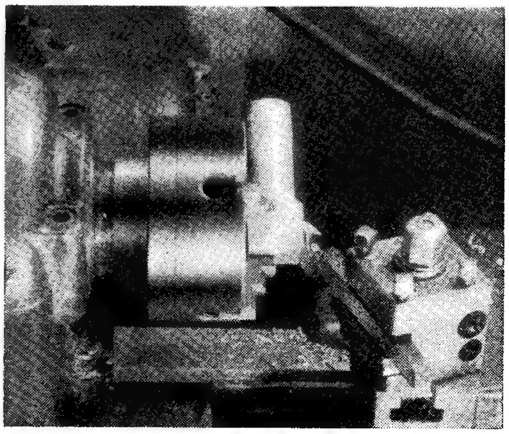
The handles were finished off with a whipping (Boy Scout fashion), thus leaving no loose ends or knots, though the finish could be adapted to individual taste.

This completes a most interesting, yet not too difficult, piece of work and nothing remains but to give it a trial.

I shall be only too pleased to answer any queries or help with any difficulties experienced in making this model. Address your enquiries to me, care of the editor; similarly, if anyone so wishes he may borrow my patterns free of charge provided he guarantees to return them in good condition, for the next chap.



Photograph No. 6. Boring out the body



Photograph No. 7. Body thrown over 5 deg. for machining taper

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

FLUORESCENT LIGHTING

DEAR SIR,—When I was studying electro-technology it was proved that a condenser and coil in series tended to cancel each other's voltage phase shift out, and resulted in a potential difference between them that may be many times greater than the applied voltage.

Further, when fluorescent lighting was examined, it was stated that the purpose of twin-tube assemblies was to obtain unity power factor in the mains supply, by using a choke on one tube (lagging P.F.) and a condenser on the second tube (leading P.F.). In parallel connection these components do not affect voltage.

From the foregoing, it would appear that Mr. Pankhurst's wiring diagram is in error.

Let us get this lighting problem in its true perspective. The best lighting layout for any workshop is in two parts. (1) general lighting to permit safe mobility of the worker, and (2) concentrated directable light for special jobs. The discharge tube, due to its rigidity, is only suitable in case (1), but for actual machining operations, case (2), an "Anglepoise" type of light is essential.

The working zone of my own shop is roughly 6 ft. square, and the general lighting consists of a 2 ft. 20-watt tube. This is ample for my needs. The lathe and drill have 60-watt "Silverlites" in "Anglepoises" and provide all the special light required in the direction required.

The danger of stroboscopic effect is much overrated. It takes a specially built "Stroboflash" to make moving machininery appear stationary. What is visible actually is moving halos around the part affected, but I have also seen this effect to a lesser degree using an ordinary single lamp as a light source; with the combination of both tube and lamp, however, it becomes unnoticeable.

To change the subject, the "Duplex" knurling tool would be more versatile if straight-cut wheels were used than helical ones shown. This would permit (a) straight knurling to be done where needed for fitting purposes, (b) ensure always that the angles of both cuts are equal, and (c) as the axes of work and cutters will cross each other, the risk of side thrust on the mandrel is reduced to a minimum.

Yours faithfully,

East Ham. A. E. CLAWSON.

REPLY TO MR. VIZOR

DEAR SIR,—I can offer the following information concerning the road locomotive Mr. H. J. Vizor is enquiring about. I am a fireman on the Western Region and pass this spot quite a few times. The engine is (or was) a Fowler, twin-cylinders, with three-quarter canopy and copper cap chimney; it was drawn up alongside the railway line and dismantled, the boiler being used to heat a greenhouse which sprung up after its being dismantled. Keeping it company now is a portable engine, also doing the same thing but not yet dismantled. I am a T.E. enthusiast and used to look out for this engine, always when passing by, and was quite disappointed when I saw it was being used for that purpose.

In conclusion, if Mr. Vizor is interested, I have on hand a few showman's and ordinary type T.E. badges left, as supplied to Pat Collins drivers and W. J. Hughes. If he is interested and writes for particulars I will gladly send him one.

Yours faithfully,

Newton Abbot. E. SIMS.

PRECISION CENTRE-DRILLING

DEAR SIR—In your issue of, February 26th, Mr. L. A. Watson, in his comments on Mr. Mellow's drilling machine states that: a bar cannot be "truly centred" by any means available to the amateur.

In case many beginners and novices are misled by such a sweeping statement, and are scared out of attempting an operation which they believe beyond their capabilities, I would assure them that it is quite a simple matter to centre a bar as truly as anyone could wish by means readily available to "us amateurs." The easiest, and possibly the most accurate, method that can be used in the home workshop, or anywhere else for that matter, is to support the end of the bar to be centred in a fixed steady, the nearer the end the better, and then true up the other end that is being driven by the lathe in a four-jaw chuck; a three-jaw will do if reasonably true. It will then be found that it is quite simple to centre the end of the bar accurately, inside "half a thou." if desired. I would also mention that it is quite possible to correct a centre that has come out a little eccentric by the time-honoured method of scraping by hand. With care, any desired accuracy can be attained. Even collets, especially if they have seen much service, would not necessarily ensure absolute trueness in a case of this sort.

Yours faithfully,

North Cave. RONALD S. TURNER.

MODEL VACUUM BRAKES

DEAR SIR,—In the letter from Mr. S. A. Ford, of Swansea, in the issue of February 26th, he refers quite correctly to what must appear to be a mistake on my part.

The normal vacuum brake system does not require a triple valve for its operation. I should have carried the matter further and mentioned that the type of braking I had in mind was for use on the new Beech Hurst track at Haywards Heath.

I am trying to evolve a method whereby any locomotive, whether fitted with an ejector or not, may make use of the vacuum brake for the passenger cars only.

This *is* possible in at least three ways, two of which require the addition of a modified triple valve.

It is hoped that some diagrams may be accepted later for publication, when the need for the disputed item may become more apparent.

Meanwhile, let me congratulate Mr. Ford for having evolved his own system, which appears to have given a good account of itself.

If ever I find myself down Swansea way, a meeting with Mr. Ford will certainly be sought.

Yours faithfully,

Worthing. J. I. AUSTEN-WALTON.

IN THE WORKSHOP

BY DUPLEX

LIGHTING THE LATHE

NOWADAYS, it is often the practice to fit machine tools in factories with self-contained lighting of either the normal or low-voltage type. This has the advantage that the light is concentrated where most needed and is kept out of the operator's eyes ; moreover, a small light in the right place means that the general lighting of the shop can be reduced, with a saving in the cost of electricity. Localised lighting of the lathe is often an advantage in the small workshop and may take the place of movable lights with untidy, and sometimes not very safe, wiring about the bench.

A Light for the Myford M.L.7 Lathe

After the lathe had been looked over to find a suitable place for attaching the light, it was decided, as shown in the accompanying photographs, to mount the lamp bracket on the machined surface at the back of the lathe bed designed as a bolting face for the taper-turning attachment.

Admittedly, this attachment and the light cannot both be used at the same time ; but the attachment is seldom required, and the lamp can be quickly detached by removing two screws. Nevertheless, an alternative method of fixing the lamp bracket is illustrated and the mounting of the taper-turning attachment is not then interfered with.

The Shade (A), Figs. 3 and 4

This part is made from tinned sheet and is left bright on the inside to act as a reflector.

The most suitable lamp bulb for the present purpose was found to be the "Ekco" Striplite of 60 W rating. The long, single filament is well supported and should withstand all ordinary vibration.

The bulb is carried in a special fitting with a spring-loaded connector at one end and a plain holder at the

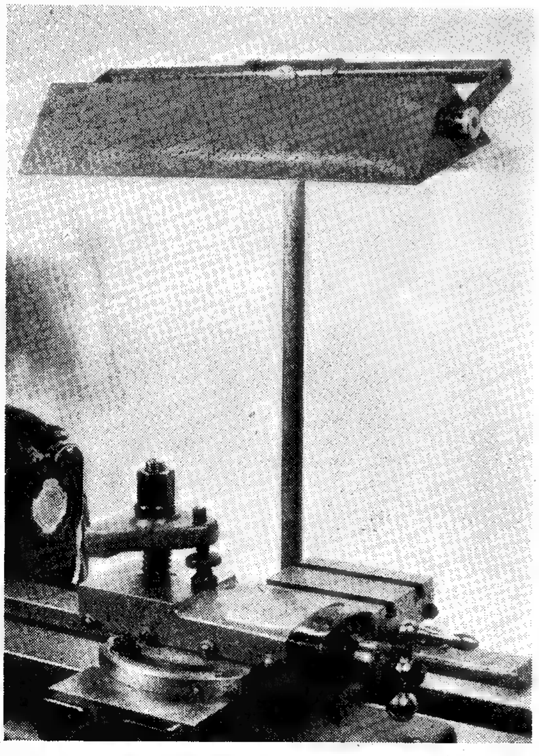


Fig. 1. The lathe light in place

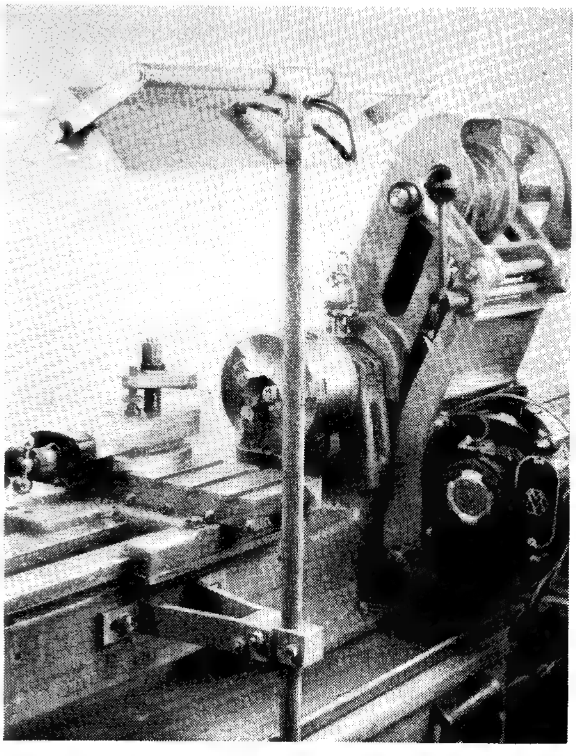


Fig. 2. Showing the method of attaching the pillar to the lathe bed

other; the mounting is attached to the shade by means of two 5-B.A. bolts.

To allow the shade to be tipped as required, a trunnion screw (*B*) is fitted at each end of the shade to carry the links (*E*), which are, in turn, secured to the ends of the T-piece (*C*) by means of the bushings and screws (*D*).

The Lamp Standard—Fig. 5

The standard is built up from $\frac{5}{8}$ in. dia. electric conduit and consists of a T-piece with extended arms (*C*) and a vertical pillar (*F*). When assembling the material, it was found that, to ensure squareness, the tubing was best screwcut 18 t.p.i. in the lathe. The T-fitting has a detachable front plate which forms a convenient mounting for the small table lamp switch. A hole is also drilled at the back of the T for the entry of the wiring, and rubber grummets are fitted where the connections are brought through a metal part.

The Wiring

As shown in Fig. 3, one lead of the flex is connected to either end of the lamp holder, and the live lead is taken to the push-on push-off switch. The wiring is continued from this point with plastic-covered, twin cable, and at the free end a two- or three-pin plug is fitted for connecting the wiring to the lathe distributor box. It is very important in installations of this kind to make a proper earth connection; either a separate earthing wire and a three-pin connector can be used, or there must be a good earth return from the standard to the lathe bed and thence to the motor earthing connection.

The Attachment Bracket (G), Fig. 6

The bracket is easily built up, using 1 in. × $\frac{1}{4}$ in. mild-steel for the side members; these are bent to shape while hot and then drilled. The central lug is formed from a short length of 1 in. square mild-steel.

The bore for the pillar should be machined to a close sliding fit on the pillar by mounting the part in the four-jaw chuck and finishing the drilled pilot hole to size with a boring tool.

If necessary, the abutment faces of the two feet should be filed flat after assembly, and the bolt holes may need opening out to register with those in the lathe bed.

Finishing

To give a good appearance, the whole attachment should be painted with grey cellulose or synthetic

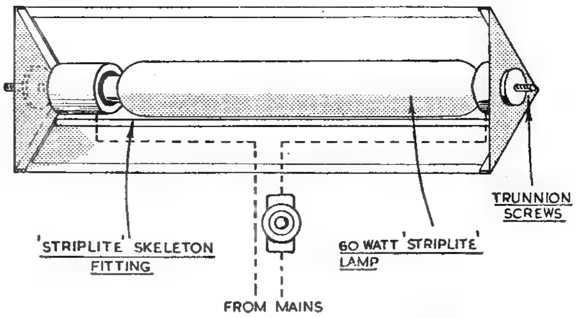


Fig. 3. The shade with lamp fitted

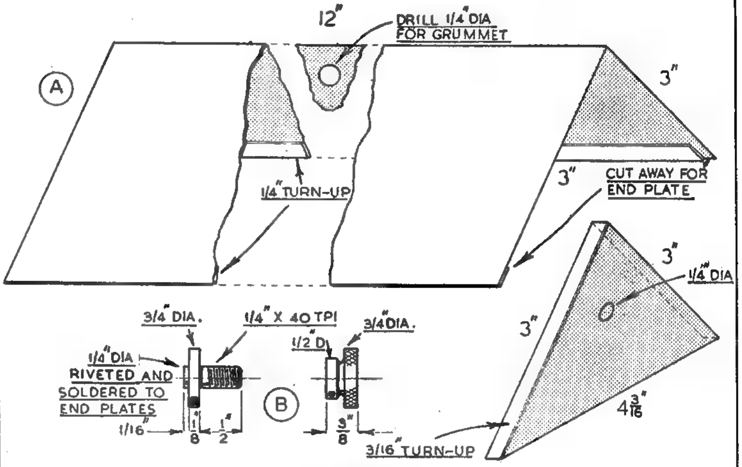


Fig. 4. Constructional details of shade

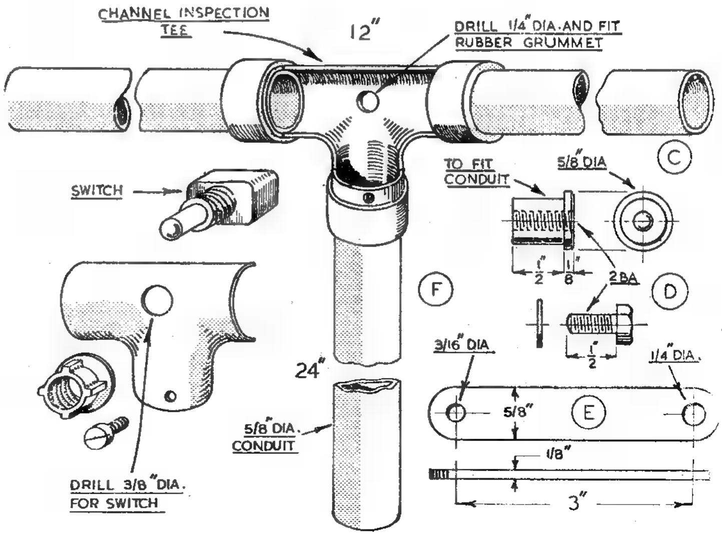
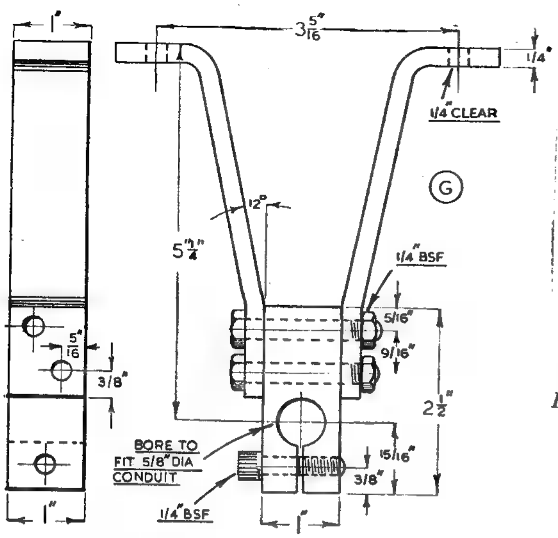


Fig. 5. The pillar and its fittings



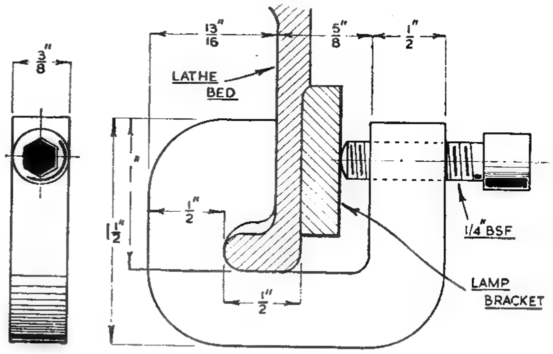


Fig. 7. C-clampsf or attaching the bracket to the lathe bed casting

Left—Fig. 6. Details of the pillar bracket

enamel to match the rest of the lathe ; or, as in the present instance, the parts can be given a more durable finish by stove-enamelling.

The Alternative Bracket Mounting

To enable the lamp to be fitted without encroaching on the bolting face for the taper-turning attachment, the bracket (*G*) is secured to the web of the lathe-bed casting by means of two small C-clamps to take the place of the screws holding the feet. As shown in Fig. 7, these clamps are made from $1\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in. mild-steel, and are fitted with a $\frac{1}{4}$ in. dia. Allen cap-screw. The throat of the clamp is shaped to pass over the rib formed on the lower edge of the bed casting.

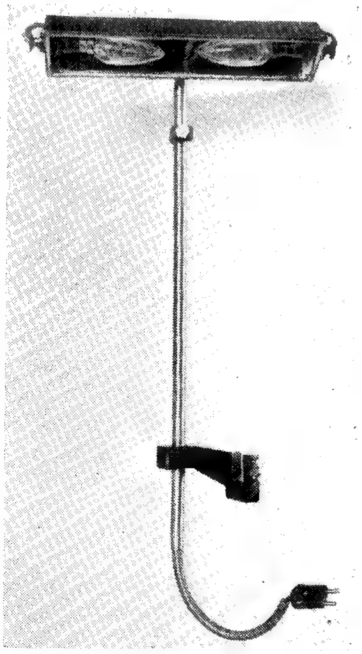


Fig. 8. The lamp for the Drummond lathe

Lighting the Myford - Drummond Lathe

The Drummond was the first of the workshop lathes to be fitted with self-contained lighting, and this was carried out rather more easily, as the pillar bracket could be attached directly to the bed casting without interfering with the working of the lathe in any way. The same pattern of shade, lamp bulb, and pillar as in the previous example can be fitted, but those in actual use are somewhat different and provide an alternative arrangement. The complete attachment is illustrated in Fig. 8.

The Shade (1), Fig. 9

This is a rather elaborate commercial fitting, 12 in. in length, with two inserted reflecting mirrors. An S.B.C. lamp holder is fitted at either end, and these also carry the trunnion screws (2) for the shade arms. The two candle-type bulbs are each of 25 W rating ; 40 W lamps of this pattern are obtainable, but they are too large for this particular shade.

The Pillar (3), Fig. 9

Again, this is built up from $\frac{5}{8}$ in. dia. conduit. The T-piece is drilled at the front and back for the wiring leads, and also at the

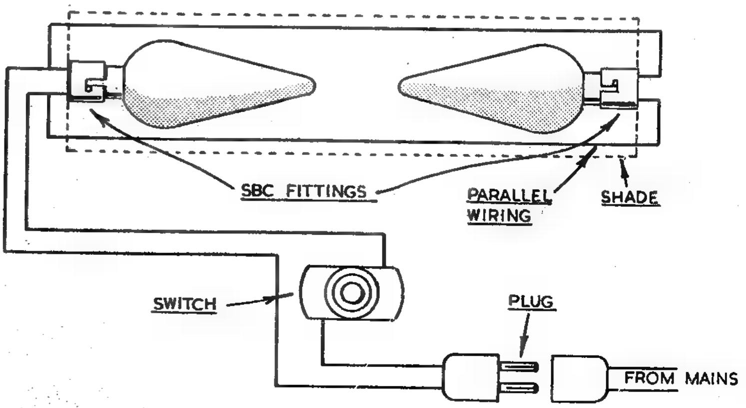


Fig. 10. Wiring diagram for the shade with two bulbs

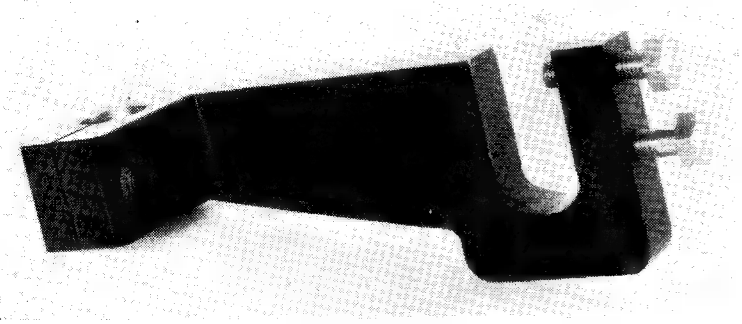


Fig. 11. The finished attachment bracket

top for drawing in the wires.

A fibre bush is fitted at the lower end to protect the wiring.

As the lathe is mounted on a wooden bench, the pillar is carried right through the bench top and the wiring underneath is then out of harm's way.

The Wiring—Fig. 10

The two 230 V lamps are, of course, connected in parallel, and the live lead is brought out at the back of the T-piece for wiring to the push-on push-off switch. The return leads are carried within the pillar and are fitted with a plug connector. The switch is mounted on the front of the pillar, where it is secured in place by means of a brass strap held by two 6 B.A. bolts. Where the wires enter and leave the switch, it is important to bury the insulated covering in the plastic plate at the back of the switch.

The Cover

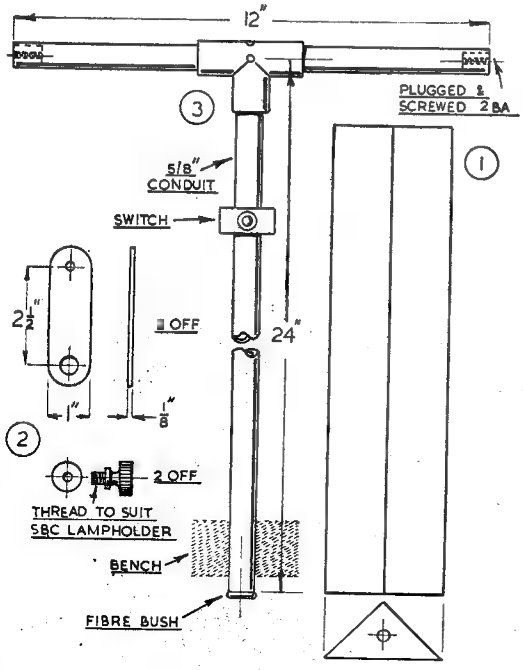
At the front, a piece of insulating material to cover the terminals is held in place by the finger-nut fitted to the switch, and any other possible live points must be properly covered.

As an alternative, a small cover can be made from plastic sheet to enclose the body of the switch, but the best solution is to fit the switch to a T-piece with detachable cover, as in the previous example. As before, it is most important that the pillar should be properly connected to earth.

The Attachment Bracket—Figs. 11 and 12

The body of the bracket is cut out from a piece of ½ in. mild-steel bar, and the throat is made wide enough to pass over the fillet on the underside of the bed casting. The bracket clamps to the web that projects downwards from the back of the lathe bed, and is held in place by two ¼ in. B.S.F. set-bolts. If the upper bolt is tightened first, there will be no difficulty in tightening the second with an ordinary spanner and, at the same time, a clear view can be obtained by looking through the open space between the bed shears. The trunnion block (5) is bolted to the projecting end of the clamp and, again, the bore should be machined to fit the pillar closely.

To assemble the lamp on the lathe, clamp the bracket in place and secure the pillar vertically in position. Mark the bench round the lower end of the pillar and then bore a ⅝ in. dia. hole through the bench top with a ratchet brace. Dismantle the connector and push the wires, with plugs attached, through the hole. The plug connector can then be assembled and inserted in the other half of the fitting after this has been connected to the mains.



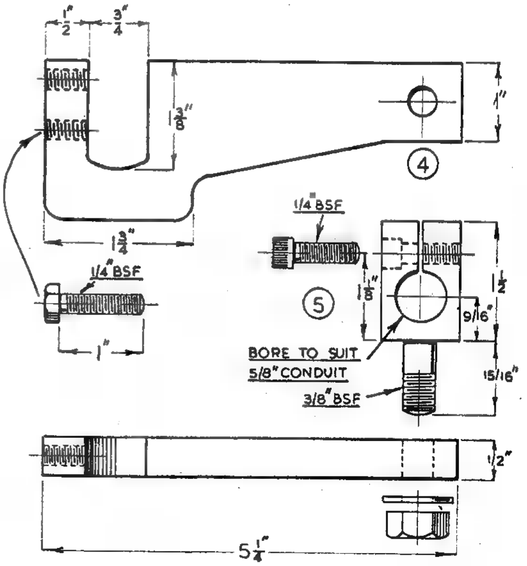


Fig. 12. Details of the pillar bracket

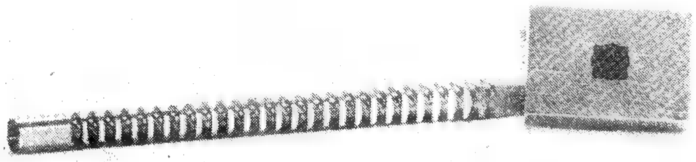
Left—Fig. 9. The pillar and shade for the bench lathe

Making and using broaches

By Lawrence H. Sparey

ONE of the strongest and most charming characteristics of the model engineer is that he can, with limited equipment, successfully undertake almost any type of job. Engineering processes, usually considered to be difficult, or at least, "tricky," may be seen by the score at any exhibition, and the manner in which these results are obtained is often a matter for interesting speculation.

A job which may be included in the above paragraph is that of making square, hexagon, and similarly shaped holes, especially if they are of any great depth, such as might be required as guides on engines and other machines. The more skilled among us may, perhaps, be able to file such holes to the required limits; but most of us, myself included, must resort to more certain methods, such as the use of broaches.



A square broach and an example of work. Broach pulled through on the lathe

The Broaching Process

In spite of their somewhat complicated appearance, broaches for square, hexagon and similar holes are not unduly difficult to make, and I have successfully made all these types using only the lathe and a file. Round broaches—the particular virtues of which will be described later—may, indeed, be made completely on the lathe only, including all the processes of backing-off.

In industry, particularly in the manufacture of motorcars, broaches are now used to an enormous extent for a large variety of purposes, and are, in fact, replacing older methods for such processes as forming round holes, cutting keyways and splines, and for forming internal gears. The reason for this is that broaching is rapid, accurate, and capable of producing a high finish, and there is no comparable method for producing accurate holes, either symmetrical or irregular, and slots and grooves in machined parts. Many of these advantages also apply to amateur work, although it is probable that only the simpler types of broaches will be required.

In industrial practice broaches are usually *pulled through* the work on special broaching machines, but I have successfully used broaches in my home workshop by the more convenient method of *pushing*. I have also pulled broaches through, in the conventional way, on the lathe, which makes a very good broaching machine.

Design Characteristics

Broaches are used for enlarging, or for altering the shape, of a previously prepared hole, and this is done by a series of teeth of progressively increasing diameter, each of which takes a thin shear of metal from the work-piece. From this, it will be obvious that there are two main factors of design; namely, the amount of increase in diameter per tooth (governed by the taper of the broach) and the spacing between the teeth themselves. These two factors are, of course, related, because the closer the teeth are spaced together on any given taper, the less difference there will be in their diameters.

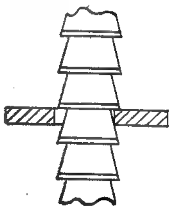
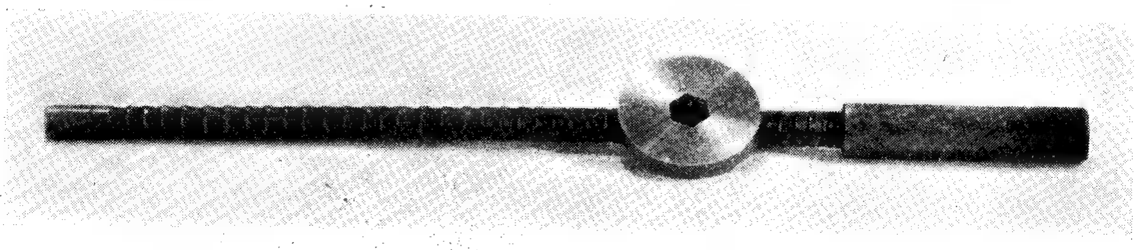


Fig. 1

Generally speaking, each tooth should not enlarge the hole by more than about 0.003 in., and this amount will be satisfactory for most steel and brass work, allowing, at the same time, for a broach of reasonable length. Where much metal must be removed, as in forming large, triangular holes, it may be necessary to use two broaches of increasing size in order to maintain reasonable tool proportions.

A consideration which may often govern the spacing of the teeth is the thickness of the work-piece. It is desirable that at least two teeth, or better still, three, should be in



A 6 B.A. hexagon broach made by the author, with an example of the hole made with it

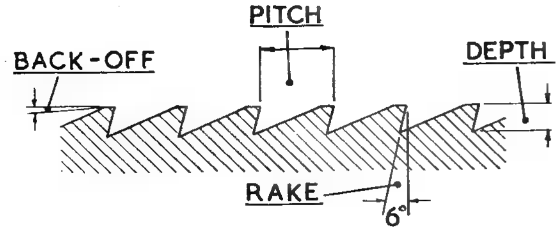


Fig. 2

contact with the work at one time. If the spacing of the teeth is greater than the thickness of the work, there is a danger of the broach being displaced, as shown in Fig. 1, where it will be seen that the work-piece has slipped sideways into the spacing. This would, of course, distort the hole.

The diagram, Fig. 2, shows the only other factors we need consider ; tooth depth, clearance angle or "back-off," and the face angle or rake of the teeth. The figures given are satisfactory for all general work on steel, brass, aluminium and bronze.

A useful working figure for depth of tooth may be taken to be equal to *half the pitch.* On small, thin drifts, however, under about $\frac{5}{16}$ in. in diameter, it is advisable to space the teeth rather closely together, with a correspondingly shallow tooth depth, otherwise the core diameter may be reduced beyond safe limits.

The *tooth clearance* or "land" need be very small, at most 5 deg. The width of the land is not of great importance — somewhere around 1/32 in.

There remains only the *tooth rake*, and this is given as 6 deg. on the drawing. Again, this is not critical, but it is advisable not to exceed this amount. This angle is determined by the angle at which the relieving tool is fed into the work, so it is quite easy to determine.

The drawing, Fig. 3, which shows a simple method of making broaches, of which more later, also shows that a portion of the broach is left parallel. This part of the broach determines the finished size. As the broach is parallel at this point, the lands need not be backed off, although a very light stoning-back can be undertaken.

At (*E*) on this same drawing may be noted a "burnisher," As will be seen, this part of the broach does not cut, but is rounded off into a spherical shape. It is not necessary for this to be a true sphere, as it may be slightly flatted during the final turning to size, and polished with fine emery cloth. If the broach is used with plenty of lubricant, the burnisher will produce an extremely high finish on the job. It is used only on round broaches.

Round Broaches

The orthodox methods of forming round holes by boring, drilling, and reaming are so much of the essence of model engineering practice that it may well be asked why another system need be added. The answer is that broaching has advantages and a certainty not found in other methods. A broach, even if not too well made, will produce a bore which is parallel, to size, and of high finish. These advantages are particularly apparent with bores of small size, such as those required for model locomotive oil pumps. Bores for small petrol engines become particularly easy to make accurately, and require a minimum of lapping. Unlike a reamer, a broach is not liable to produce a bell-mouthed bore—that bugbear of engine enthusiasts.

Making Round Broaches

Having used round broaches for many years, I have evolved a simple method of making these entirely on the lathe, entailing nothing more than plain turning operations, and the system is set out, in machining sequence, in Fig. 3.

Drawing (*A*) shows the first step. The material selected should be of larger diameter than that of the finished broach, and a shank of convenient size should be turned at one end. At the other end a "pilot" is formed, the purpose of which is to locate in a preliminary hole in the workpiece. This pilot, together with the main body of the broach, should be turned between centres

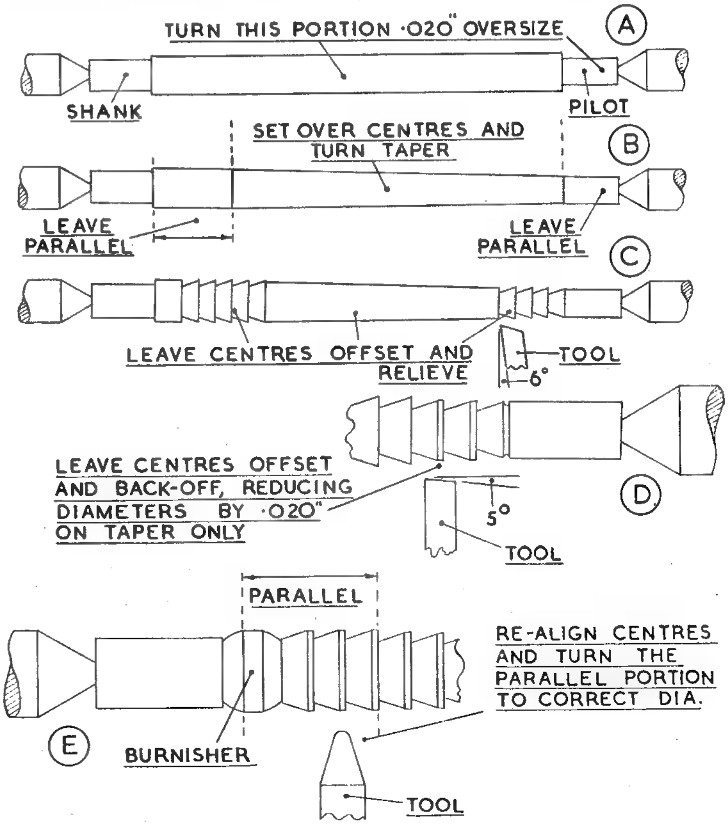


Fig. 3

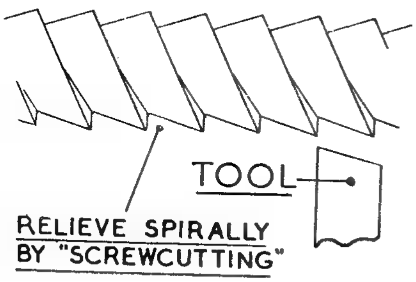


Fig. 4

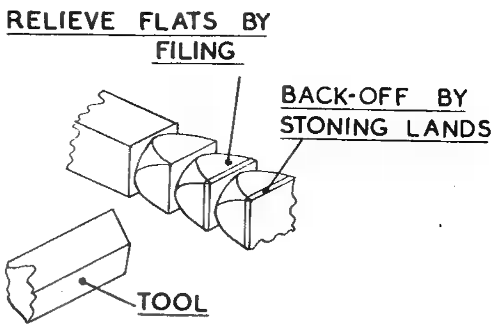


Fig. 5

to be 0.020 in. larger than finished sizes.

The drawing (*B*) indicates that the lathe centres have been set-over for turning the required taper, but it will be noted that a short parellel portion is left on the main body of the broach, and that the pilot and shank are left parallel also.

The manner in which the teeth are cut is shown in drawing (*C*). Here it will be seen that a lathe tool, ground to the appropriate angle, is plunge-cut into the work, thus forming the teeth. The tool is advanced into the work by means of the *top-slide*, which is set at an angle of 6 deg. In this way the rake on the front of the teeth is imparted. The tool should be plunged into the work until the sharp edges of the teeth coincide with the diameter of the work-piece. Once the required amount has been determined, all the other teeth may be similarly formed by working to the top-slide index. Tooth spacing may be determined by means of the leadscrew handwheel, which may be marked with chalk if it is not itself indexed. The lathe centres are still off-set for this operation.

In broaching round holes the pilot hole need be only slightly smaller than the finished size, and about 0.025 in. difference is all that is required. If a lesser difference than this is used, it becomes difficult to turn the very fine taper required on the broach. As such a small amount of metal has to be removed, each tooth need cut but very little metal, and the broach need not exceed about 10 in. in length, and even less in the small sizes under $\frac{3}{8}$ in. in diameter.

In drawing (*D*) we see the method of giving clearance or "back-off" to the teeth. A great advantage of this system of backing-off is that we do, at the same time, reduce the broach to its correct size, thus ensuring not only sharp cutting edges, but also that the teeth are really backed-off to the edge.

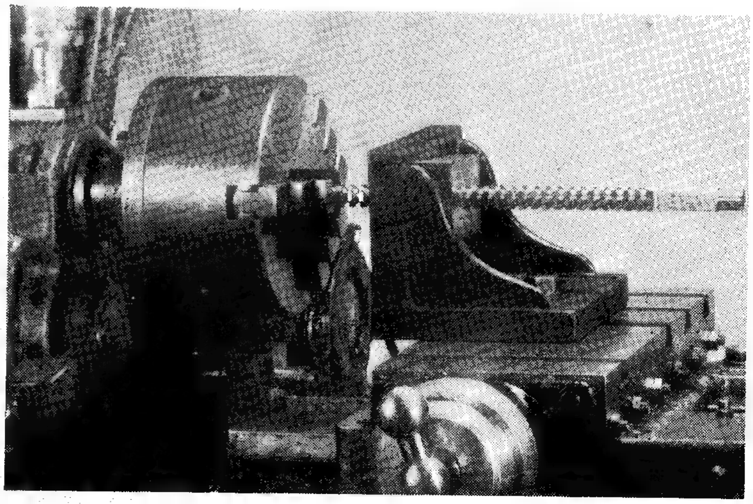
The backing-off tool should be shaped like a parting tool, with the front edge ground back at an angle of about 5 deg., as shown in the drawing. The tool is advanced until it just touches the sharp edge of one tooth. It is then advanced 0.020 in. (which, you will remember, was the amount left oversize), and the index reading noted on the cross-slide. If the tool is then moved along the job, by indexing off the leadscrew handwheel as before, and advanced to the cross-slide index reading, each tooth will be backed-off and reduced to its correct diameter. I have found that absolute precision is not necessary, and it is quite sufficient to rely upon the index readings. It will be particularly noted that only the *taper portion* of the broach is backed off at this operation.

The final drawing (*E*) shows the manner in which the *parallel portion* of the broach is backed-off. The operations depicted in drawings (*B*), (*C*) and (*D*) have all been done with the lathe centres set-over for taper turning. For operation (*E*) it is necessary to reset the lathe centres for parallel turning. It is then necessary only to turn the parallel portion to the correct size. The pilot is also turned to size at this setting.

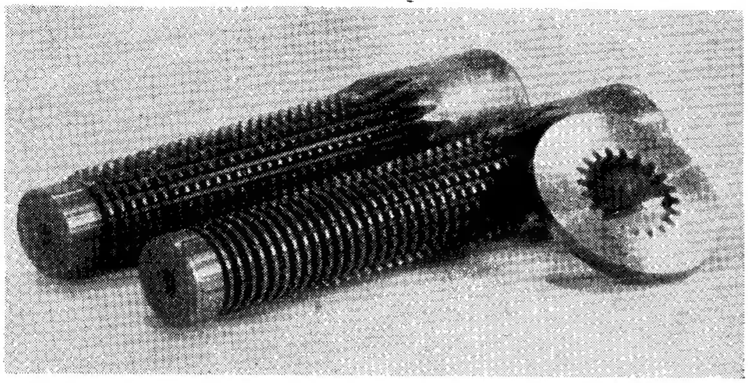
Spiral Broaches

In Fig. 4 is shown a portion of a *spiral broach* which is extremely simple to make on the lathe. As may be seen, the teeth form a continuous helix, the advantage of which is that they give a shearing cut.

The procedure for making this broach is the same as that shown in Fig. 3, except that the teeth are not plunge-cut, but are formed by traversing, as in screwcutting. This type of broach is probably more suitable than any for amateur production.



Using the lathe as a broaching machine, whereby the work is pulled along the broach



An outstanding example of broaching by Mr. J. R. Wuidart of the North London S.M.E. A pair of push-broaches for forming an internal gear

Square, Hexagon, etc., Broaches

The variety of holes which may be cut with broaches is really only limited by one's ability to shape the tool to the correct section.

Square broaches of standard sizes may be made from square section silver-steel, which may be obtained from most tool dealers. Hexagon, triangular, and other shapes may be milled from round stock in the usual way, but for the amateur there is probably no better system than that provided by the *filing rest*. I would draw the attention of those unfamiliar with this most useful tool to the article by Mr. H. E. White which appeared in THE MODEL ENGINEER issue dated February 14th, 1952.

In making these broaches a slightly different procedure is followed from that of the round type. Both the shank and pilot are turned as in (*A*) Fig. 3. Lathe centres are then set-over, as in (*B*), and the taper formed, but in this instance it is finished *dead to size*. This will be, of course, the across-corner measurement of the hexagon or other figure. The short, parallel portion on the main body is again retained. The desired section may now be formed by milling or by the filing rest.

Again transferring the work-piece to the off-set centres, the teeth are formed in exactly the same way as is shown at (*C*) Fig. 3, but it will not be possible to form a backed-off edge on the whole circumference of the material, due to the fact that the tool will remove most material from the corners. The result is depicted in Fig. 5. Failing a complicated milling set-up, the only alternative is to relieve the flats by careful filing almost up to the cutting edges. The final backing-off on the lands may be done with a slipstone.

Materials and Hardening

Broaches may be made from silver-steel or any of the hardening steels used for toolmaking. Recently, however, much attention has been given to the possibilities of case-hardened mild-steel for use as cutting tools, and a British firm of world-wide reputation is now marketing a range of expanding reamers in this material. I have used these reamers and can detect no differences between them and those of the orthodox materials.

Following this lead, I have made and used broaches of case-hardened mild-steel with every success; in fact, there seems to be less liability for them to warp in the hardening. Warping is, of course, a danger, but this seems to be lessened if, before hardening, the broach is first raised slowly to a red heat and allowed to cool naturally. The mild-steel broach may then be placed in a metal tube, packed with casing compound, and hardened in the usual way. Tool-steel broaches should be tempered to a light straw colour, but silver-steel should be lowered to a medium straw colour. When hardened, the cutting edges may be lightly slip-stoned to restore their keenness.

Using Broaches

As already explained, broaches are drawn or pushed through a pilot hole in the workpiece. For square or triangular holes, the pilot hole is usually made slightly larger than the across-flats measurement. The resultant hole is, therefore, not a true square or triangle, but appears as shown in Fig. 6. The method relieves the strain on the broach to a large degree, and the result is rarely objectionable in practice. Pilot holes for hexagon and other multi-sided shapes may be only very slightly larger than the across-flats measurement.

Small broaches may be pushed through the work-piece on the drilling machine, holding the shank of the broach in the chuck, with the work-piece supported by the drill-table, but a better plan is to use the lathe. The headstock should be locked, by engaging the backgear, and an angle-plate, having a suitable slot, should be bolted to the cross-slide. This acts as a support for the work-piece. The broach is then passed through the prepared pilot hole in the work, and the pilot-shank of the broach gripped in a chuck on the headstock. Movement of the

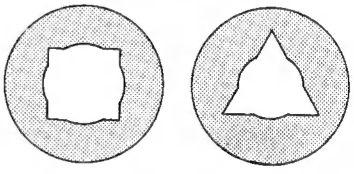


Fig. 6

work-piece may be obtained by engaging the leadscrew nut and moving the carriage by means of the leadscrew-handwheel. In this way, the work is drawn along the broach, which is, in effect, equivalent to drawing the broach through the work.

During the operation of broaching the work should be flooded with lubricant, either soluble cutting oil or plain cutting oil as used for turning purposes. Lubricant should be used on all metals, including brass and cast-iron, as this will impart a very high finish.

OUR COVER PICTURES

Readers of *THE MODEL ENGINEER* are invited to submit for consideration photographs which may be suitable for cover pictures. The subjects must be within the scope of this journal and reference to the covers of this year's issues of the "M.E." will give an indication of the type of photograph preferred. If accepted for publication, a reproduction fee of two guineas will be paid.

Prints should be addressed to

The Managing Editor, THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

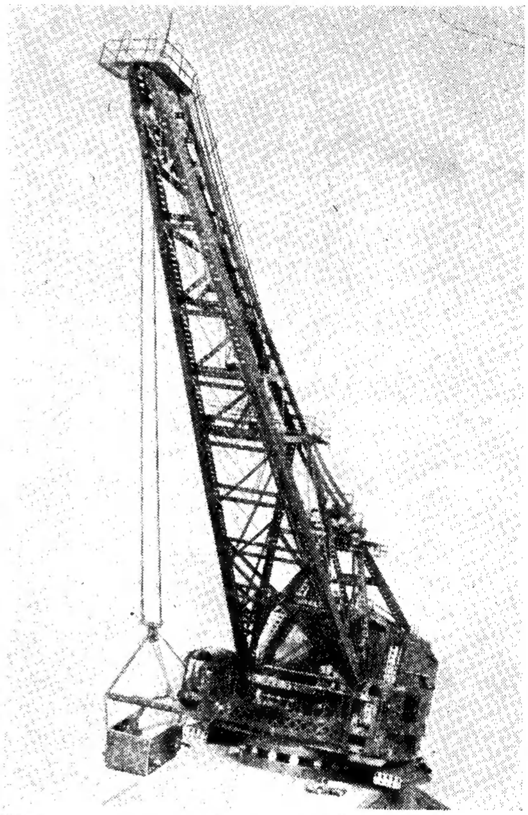
A Model of the
Rapier Walking Dragline

By H. W. Henry

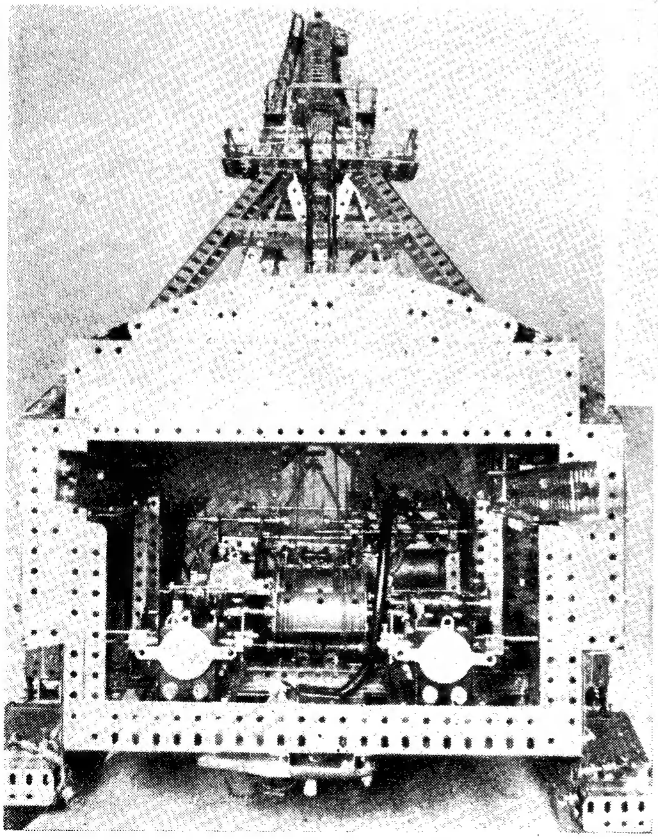
THIS model has been built with standard Meccano parts (scale approximately 1/50th). The main body of the dragline houses the cable drums, also the electric motors which operate the five individual movements. (See photograph showing rear of cab.)

The bottom centre motor, which is not visible in the photograph, operates the walking mechanism. This mechanism is driven through a reduction gear of 175 to 1 which in turn is geared to the shafts, which operate each leg. The eccentric mechanism is built up of 3½ in. gear wheels giving an epicyclic movement. One revolution of the eccentric gives a walking distance of 1½ in.

The ladders, which run the entire length of the jib to a platform at the top, give easy access to key points in the jib for maintenance, i.e. cable pullies and attachment points. The ladders and hand-rails are made of 18-s.w.g. wire.



The completed model
Length of jib, 5 ft. 4 in.
Width (from outside of feet), 1 ft. 8 in.
Height of cab, 1 ft. 3½ in.
Length of cab from rear to front of control cabins, 2 ft, 2 in.
Length of feet, 1 ft. 0½ in.
Width of feet, 2½ in.
Size of bucket, 4½ in. × 3 in. × 3½ in.
(This digs, drags and lifts approximately 9 oz.)



Left—View of cab from rear. The individual movements are as follows :—
Extreme left—operates drag
Forward left—operates swivelling
Forward right—operates jib
Extreme right—operates bucket
Forward drum—holds jib cable
Centre drum—holds drag cable
Rear drum—holds lift cable

QUERIES AND REPLIES

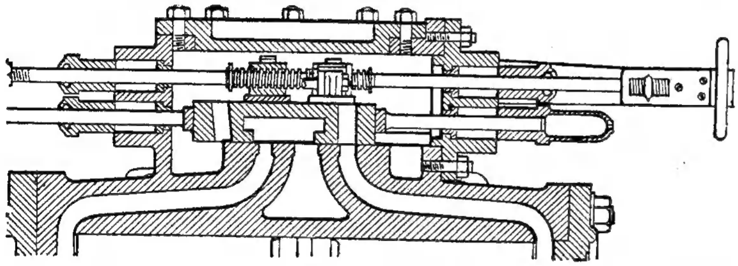
"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with :

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Variable Expansion Gear

I have a steam engine, the ports of which are $\frac{3}{16}$ in. by 1 in., and exhaust $\frac{3}{8}$ in. The engine has a bore of 2 in. and a $2\frac{1}{2}$ in. stroke. I would like to fit a variable expansion gear which will give a wide range, enabling me to cut off very early or very late. Steam pressure is 200 lb.
M.L. (Stamford Hill).

You do not state whether you need an automatic expansion valve-gear or one operated by hand. You could use a Stephenson link motion, which would enable you to vary the expansion and would also make the drive easily reversible. If you do not particularly require the reversing action we would recommend the "Meyer" gear for preference (*see illustration*).



Increasing Capacity of Lathe

I wish to adapt my $3\frac{1}{2}$ in. lathe for wood turning, and propose to increase its capacity for dealing with large diameters of wood such as table tops, lamp bases, etc., by using a length of shaft held in the chuck, the other end being screwed to take a chuck or face plate beyond the end of the lathe bed. An improvised tool rest would also have to be arranged on this end of the bed.

(1) *My difficulty is to make a bearing of some kind to support the shaft on the tailstock end, and I should appreciate your advice on this.*

(2) *Can you tell me how holes of great depth are drilled in wood, as mentioned in articles in recent issues of* THE MODEL ENGINEER.
D.H. (Timsbury).

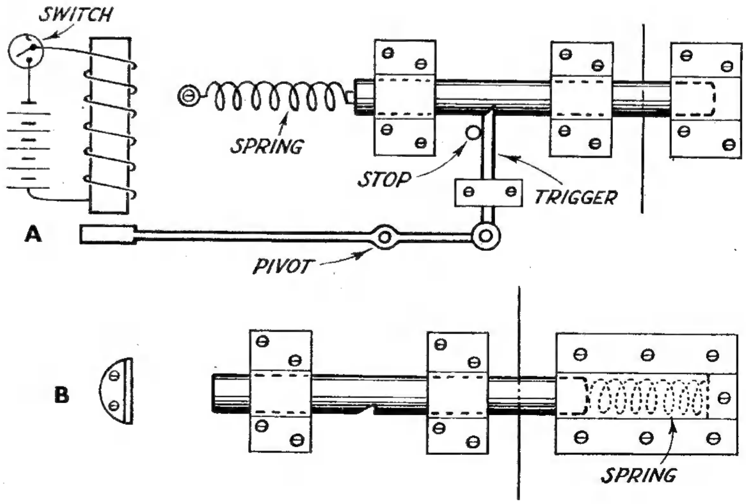
(1) The use of a wooden steady bearing has been found quite satisfactory for wood turning, and it may be produced quite easily by bolting a block of wood of the required size on the lathe bed, and boring it from the mandrel by means of a traversing boring bar. An alternative method, which could be done without special equipment would be to arrange the wood block to rest on the bed and connect it by an angle bracket to the saddle so that it could be traversed over a fixed boring bar held between lathe centres. The durability of the bearing will, of course, be increased if it is fitted with a bronze bush.

(2) The method employed for drilling deep holes in wood is to use a special form of hollow back centre, either mounted in the tailstock or in an alternative fitting, and insert a long wood boring bit through it.

Electric Control for Door Bolt

Can you suggest an arrangement for withdrawing the bolt of a door by means of electrical control? I want the actual control to be in another room and am wondering if this is a practical proposition?
A.N. (Liverpool).

It would take a very powerful electro-magnet to operate a door bolt through any distance, since, apart from the weight of the bolt, considerable friction and binding has to be reckoned with. We therefore suggest the arrangement shown in the sketch, movement of the bolt being by means of a spring in tension (shown at *A*) or in compression (as at *B*), the spring, in the latter case, being contained in the bolt socket screwed to the door jamb ; the socket would have to be fairly long, of course. The electro-magnet would be used to operate a "trigger," as shown at *A*, transmission to the trigger being via a lever, the longer arm of which would be on the magnet side of the pivot, thus providing leverage. If a notch is filed in the bolt, the trigger could engage in this to hold the bolt in the closed position until the trigger is pulled back.



Boiler Problem

I am making a vertical boiler to the following specifications: Working pressure, 50 lb.; exhaust up chimney; boiler fired with coal; boiler shell made from 3/32 in. copper, height 14 in., diameter 7 in.; firebox 7 in. high; eighteen $\frac{5}{8}$ in. solid-drawn copper tubes are used. I should be grateful for your advice on the following points:—

(1) *Height of water level?*

(2) *What size engine and dynamo would boiler drive?*

(3) *Would $\frac{1}{8}$ in. pipe be large enough for check-valve?*

(4) *Would $\frac{1}{4}$ in. bore be suitable for safety-valve?*

V.F. (Walthamstow).

(1) Water level should be at least half way up the tubes.

(2) Heating surface of boiler is 350 sq. in. If the steam is kept quite dry, it should work a $1\frac{1}{4}$ in. by $1\frac{1}{4}$ in. vertical high-speed engine at 500 r.p.m., with boiler pressure kept at 45 lb. Such an engine would drive a 10 to 15-watt dynamo.

(3) No; a bore of at least $\frac{1}{8}$ in. is needed for passages and pipes.

(4) A bore of $\frac{1}{4}$ in. would be suitable for the safety-valve, which should be the spring direct-loaded type.

Converting a Generator

Please advise me if a P.I. American Airforce Generator 200 *amps* 28.5 *volts is capable of being converted to a welding unit. What alterations to winding or connections? Is a* 6 *h.p. engine suitable for driving, and what speed do you recommend?*

N.W.L. (Ivybridge).

Your generator is unsuitable for any form of welding. For welding in the accepted sense, 80-100 volts are necessary; in addition, the generator is not an ordinary generator, it is a machine specially compounded so as to have what is known as a drooping voltage; this feature takes charge of the short circuit conditions at the instant of striking the arc. So far as increasing the voltage of your generator is concerned, little can be done, apart from a field coil rewind. As the full details of the field system of the generator are not available, it is impossible to suggest anything in this line. The h.p. you have would be sufficient to drive a generator of this size. Its present speed cannot be estimated, as we carry no data of these surplus machines. Probably the speed would be high, in the region of 4,000 r.p.m. or over.

WITH THE CLUBS

Eltham and District Locomotive Society

The next meeting will take place at the Beehive Hotel, Eltham, at 7.30 p.m., on Thursday, April 2nd, 1953, which will be the annual general meeting. It is hoped that members will attend in force as on recent occasions, and it has been the custom in the past for members to bring along with them some part of their locomotives that can be easily carried to provide a show to enable new members and visitors to see the type of work upon which they are engaged.

At the last meeting, Mr. Connor brought along the chassis of his $3\frac{1}{2}$-in. gauge "Decapod" Great Eastern locomotive, and gave a very interesting talk and description of the construction, and had gone to great pains to obtain the facts and history of this unusual type of locomotive. We are looking forward to seeing it on the track in the near future.

We were very fortunate again at this session in having the attendance as visitors of Mr. Overton, Mr. Stone, Mr. Gilham and, a very agreeable surprise, Mr. Austen-Walton of "Twin Sisters" fame, and whom the society were especially pleased to welcome. Mr. Walton very kindly came forward during the evening and gave the society a short talk on the machining of stainless-steels and the tensile strengths of copper, etc. He has promised to provide a lecture in the near future.

It is again stressed that visitors are always cordially welcomed.

Secretary: F. Bradford, 19, South Park Crescent, S.E.6.

Croydon Society of Model Engineers

The photograph reproduced on this page is of our 5-in. gauge 1-in. scale club locomotive during construction. This locomotive is of Messrs. Reeves & Co.'s design (*Gert*) who supplied drawings and castings.

The name given to this locomotive is *Pop*, so named after our president, Mr. "Pop" Cooper, who is well over 80 years of age. He and many other members have made this a "club effort." It was commenced in August, 1951, the steam trials taking place last September, and we hope to have it running this coming summer.

The photograph was taken by K. G. Duncan.